SHACKLED to the bench? Enslaved by the economic royalists? Hardly. This punch press operator works instead for a concern that knows the hand is not always quicker than the die. On this particular job the hands won't be there when the die descends; the guard pulls them out of the way. Only one of many machine guards used at IBM—where the loss of a hand is something not to be tolerated. See exhibits in May *Factory*.

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Factory

MANAGEMENT AND MAINTENANCE

April, 1938

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Factory's Fourth Annual Special Section on

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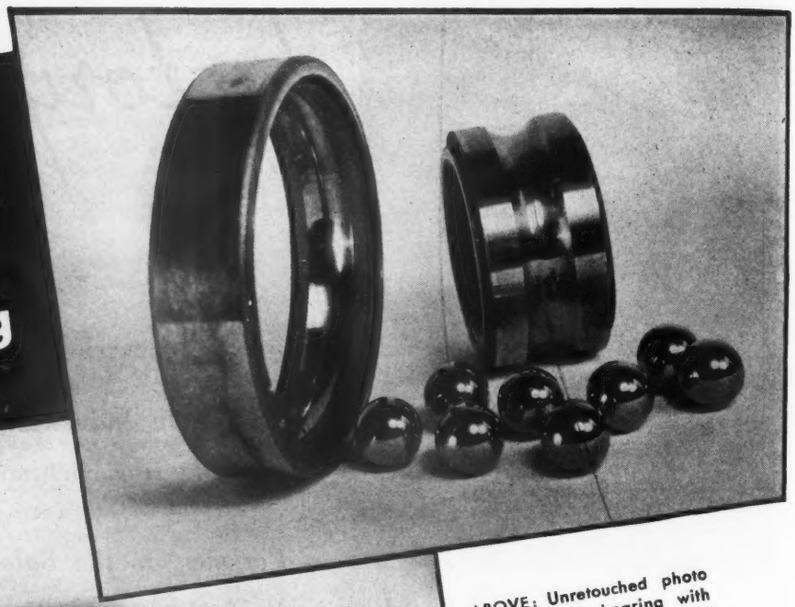
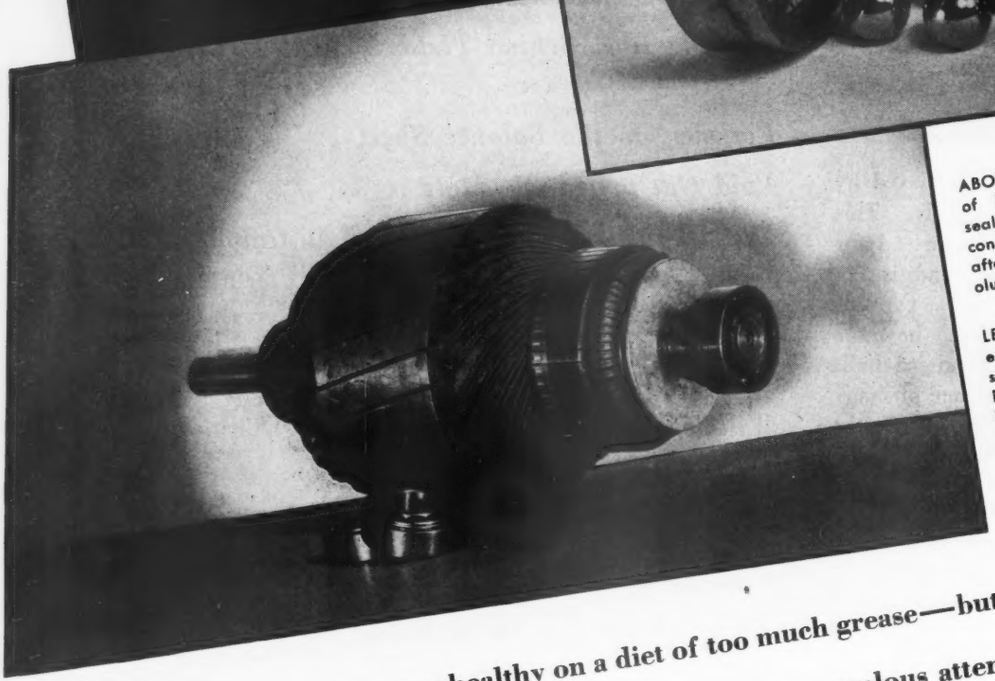
Rx Prescription for Over-greasing





ABOVE: Unretouched photo of N-D-Seal bearing with seals removed to show perfect condition of balls and races after many millions of revolutions in service.

LEFT: Motor armature after equivalent of 8 years constant service on N-D-Seal bearings. Bearings never relubricated. Put back into use with original grease.

NO motors can stay healthy on a diet of too much grease—but N-D-Seal equipped motors dont worry about overzealous attentions of a lubricating crew, for not only are they self-sealed to keep their own grease where it belongs, but their seals also keep *unwanted* grease *out*. . . . The interesting story of N-D-Seals is told in Booklet D-12, which will be gladly sent upon request.

New Departure, Division General Motors Corp., Bristol, Conn.

NEW DEPARTURE
N-D-SEAL BEARINGS

Factory
Management and Maintenance
L. C. MORROW, EDITOR

A Case in Industrial Economics from Republic Steel

REPUBLIC STEEL opened its new 98-in. hot and cold strip mill last month. A new steel mill is news at any time. It is *big* news when its advent coincides with a valley in the business cycle. This combination entitles it to recognition as a symbol of faith in the future of American industry, and a tribute to the genius of the men who direct the destinies of Republic.

The new mill is all of that, but it is more. It is recognition of the soundness of basing our national future upon the widest use of technological development in order that industry can produce more wealth for more people.

The new mill is also a monument to the industries whose products have been coordinated into a gigantic combination that functions without fuss, at high speed, to turn out a precision product.

Let us put down, without attempt at functional sequence, a list of some of the machines, mechanisms, instruments, and parts that make up the steel-producing machine as a whole:

Two 2-high and ten 4-high rolling stands; three continuous heating furnaces; 1,420 motors from 2-watt power to 4,500 hp. (58 of them of 100 hp. or more, 23 of 1,000 hp. or more); five main lubricating systems that carry 73,000 gal. of lubricating oil in circulation at one time; 20 other lubricating systems, with a combined capacity of 8,000 gal.; seven greasing systems for 4,000 bearings; 8,000 other bearings lubricated by portable grease pumps.

Run-out and hot-run tables with top speed of 2,350 ft. per min. and with 278 rollers, each driven by its own motor; an oil-hydraulic system for roll balancing; a 1,200-lb. water-spraying system; 27 electrically operated overhead cranes; slab reducer; slab turner; flying shear; hot coilers, with nine roll motors each; water pumps; spray pumps; air compressors.

Electric pyrometers; visual temperature indicators; automatic temperature recorders; electric roll-opening indicators; magnetic clutches; limit switches; transformers; electric instruments and controls of many kinds; 143 miles of conduit; 227 miles of electric wire and cable.

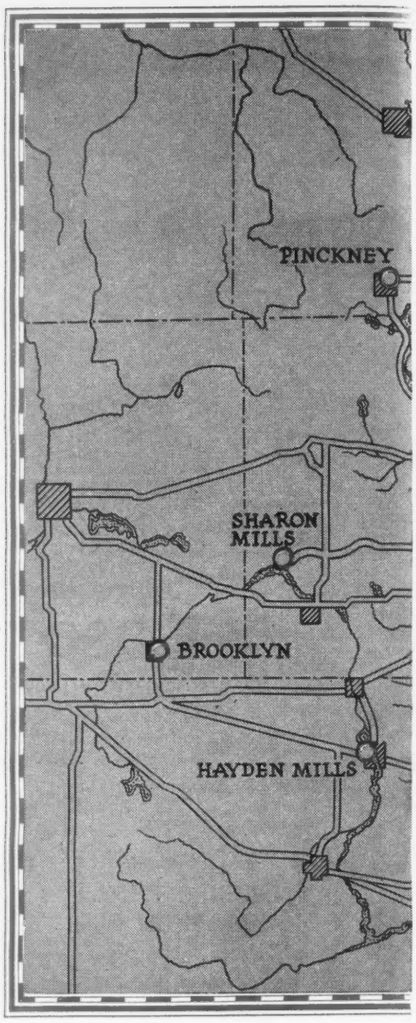
This is but a feeble list compared to the total itemized list that could be compiled. Even so it indicates the inherent interdependence of industrial plants, large and small. For back of each of the products of contributing plants stand other plants making materials, mechanisms, and parts—plants with their own coordinated activities in industrial research, design, manufacture, and marketing.

STEEL is a big-plant product and no getting away from it. Steel must be made on a volume basis to justify prices that will make it readily available to the consumer. But steel's big plants cannot exist without small-plant contributions of equipment. Nor could so many small plants exist, or the fewer number exist so well, without orders from the steel and other big-plant industries.

So, in this new mill of Republic is demonstrated again, in convincing fashion, how the American system of industries motivated by free enterprise brings about an unplanned, unregimented, but positive and effective coordination of research, design, manufacture, and distribution to culminate in that type of public service which takes continuing and positive action toward an ever higher standard of living for the people of the nation.

The BIG Idea Behind Those SMALL Plants of Ford's

ARTHUR VAN VLISSINGEN
Consulting Editor



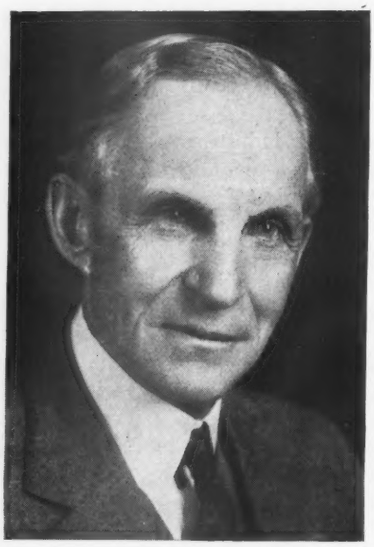
EVERYBODY talks about industrial decentralization, the same as they do about the weather. But there the analogy ends. Because somebody most decidedly *is* doing something about it. Several somebodies. Notably Ford Motor Company. Ford has 16 small plants spotted at strategic points, each one on a river where water power runs the machines at a small saving in power cost. Eight more sites are ready, with buildings up, jobs determined, and waiting the signal to go ahead.

Twelve plants, seven sites, are shown on the accompanying map.

What these plants are like, how they work out, and what they indicate as a major trend of industry, are important not only to the big manufacturer who might decentralize some of his own operations, but also to the man who owns or manages a small plant independent of any large corporation. The small manufacturer must find the subject significant as showing what he can hope to do, and also what to expect of his big competitors.

To understand this program, it is necessary to understand exactly what Ford means by decentralization. It is not setting up branch assembly plants to save by hauling solidly packed carloads of parts instead of less compact finished automobiles. Nor is it relocating plants from North to South or from city to country to tap a lower wage market.

What Ford means by decentralization is taking out of a main plant—which is almost invariably the huge Rouge plant—some units of output and having them thereafter made in small plants out in the country. In these small plants the company maintains the full Ford wage scale, and several of the plants are preponderantly staffed with men drawing the highest hourly rates in the company. Freight saving cannot be the incentive, since much of the material has to be trucked out from the Rouge

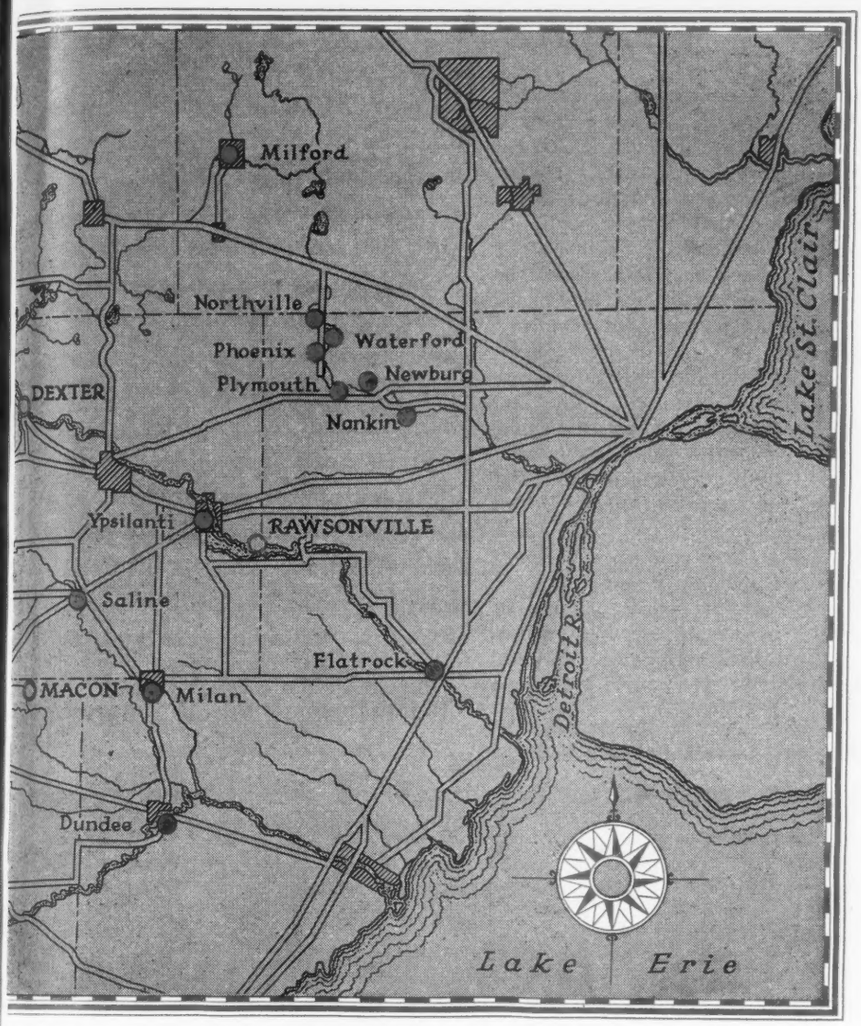


HENRY FORD is probably more interested in the country plants than in any other Ford Motor Company activity except the car itself. He gives them more of his time and more of his personal attention.

"Taking a few operations away from the large plants and putting them into small plants does not mean that mass production and centralization were mistakes in the first place," Mr. Ford likes to point out. "It simply means that, having learned certain things in centralized mass production that could not have been learned otherwise, we can now apply them in small plants. Decentralization is not a retreat or a confession of error, but an extension of the fruits of experience.

"The small plant in a village or in the country makes for better working conditions, because it permits a more natural life. This, of course, is primarily due to the village or country itself. The life of an American village is a pretty fine thing. What the small industry can do is to make it possible for people to continue to enjoy the wholesome life of the country and at the same time enjoy a city income.

"Removing industry to the country for the purpose of paying lower wages is not decentralization. It is the lack of income that drives people from the country to the city. A city income in country surroundings is easily possible—and that is what our small plants are intended, for one thing, to demonstrate."



Nobody in the Ford organization believes that centralized manufacturing is in its twilight. But the small plant as Ford has worked it out demonstrates great possibilities of advantage for small, light, easily transportable articles that acquire a good deal of added value in manufacture. The map shows the handful of small Ford plants that dot the Detroit countryside. Solid dots mark actual plants; circles, plants in progress or in prospect

and the finished product trucked back.

Anyone who knows Henry Ford's working principles knows that the branch plants are not primarily undertaken as a form of social uplift. To be sure, Ford has plainly and frequently stated his belief that this country would be better off if a larger fraction of its people could work on the farms and in their gardens in the growing seasons, and draw factory wages when not occupied by the land. But he would never undertake to bring about any such condition as a company enterprise unless in so doing he could at the same time improve the job, do it more profitably. It just so happened that what proves best industrially also turns out to be an improvement socially.

So we may confidently expect a production reason behind the engineers who continually look through the Rouge plant to find jobs that can well be moved out to small plants. It cannot be solely power savings, since power costs are almost as low at the huge Ford generating plant as they could conceivably be in a 50-hp. water plant.

"Ford" on Every Ripple

The real point is that a small decentralized operation, through its wholesome effect on the human factor, brings better work at lower cost. This is the economic reason for the small plants that stud the banks of the Huron, the tiny Rouge, and the tinier Raisin at intervals so frequent that the natives say every ripple in the lower reaches has "Ford" stamped on it.

Consider, as Exhibit A, the Waterford plant, which employs 65 men and uses a total of 52 horsepower.

Waterford is one of the tiniest of the rural plants, and one of the most notable. Here are made all the precision gages used in Ford inspection. Engineers at the Rouge are properly proud of the large number of automobile parts they make to 1 or 2 ten-thousandths.

At Waterford the superintendent takes visitors to the basement to see round and flat steel shapes "roughed out," and when questioned yields the astounding information that this roughing out is to a tolerance of 2 ten-thousandths. Upstairs, where the roughed-out blanks go for real metal-working, much of the work must be accurate to 8 one-millionths, and precision grinding is considered merely the preliminary step to cast-iron lapping.

When these men used to make inspection gages in their own tiny department of the Rouge plant, they were just so many highly paid workmen among 85,000. Their job was important, they knew, but it was overwhelmed by the plant's total immensity.

Out here, the real importance of making top-quality precision gages has a chance to be felt. The men are not a sub-sub-department tucked off in a corner and almost forgotten. They are a separate little industry, making the measurement tools without which precision production would be impossible and the modern motor car therefore non-existent. Talk with any of the men. You get a feeling of craft and personal pride which you thought had

WHAT THEY MAKE

DUNDEE	*Copper Castings*
FLAT ROCK	*Headlamps*
MILAN	*Ammeters*
MILLFORD	*Carburetors*
NANKIN	*Die Engraving & Badges*
NEWBERG	*Twist Drills*
NORTHVILLE	*Valves*
PHOENIX	*Voltage Regulators & Stop Switches*
PLYMOUTH	*Taps*
SALINE	*Soy Bean Products*
WATERFORD	*Inspection Gages*
YPSILANTI	*Starters & Generators*

long since vanished from the factories of the earth.

"That man working over yonder? The best lapper in the world, and every man in the plant will fight if you doubt it! That kid over there, doing precision work? Well, sir, he came in as an apprentice and within two years he was a precision gage-maker, the fastest development anybody around here ever saw or heard of. But say, he's one in

a million. Most of us started at gage-making when we were finished machinists, and it took us ten or twelve years to get good enough to trust with that grade of work.

"Instruments? Anything we need we get. Why, every two months the boss takes three full sets of Johansson precision blocks and dumps them in the scrap pile because by then they have been used eight months and are not good enough for this plant any more."

A Bunch of World Beaters

"Inspectors in this plant? Don't be silly! Where could you find anybody to inspect us? Any man out here—yes, or an apprentice after he has been here for a year—knows so much more about inspection than any cross-eyed inspector in an automobile plant that it isn't even funny. What do we need of inspectors? Any man who turns out a piece of work at Waterford and it isn't accurate to specifications doesn't need an inspector. He needs to go get a job running a punch press. We're the only department in the whole Ford Motor Company that doesn't have any inspectors. What do you think of that?"

Cocky? Assuredly. Swell-headed? Not a bit. Each man is good, but he knows that over at the next bench there is a man just as good or even a little better. The spirit is one of pride at belonging to such a world-beater of a unit, The best factory in the best automobile company—that is about what they think of their outfit. Did you ever find that kind of college spirit tucked away in a big mass-production factory? Neither did I.

At the other extreme of size among the Ford decentralized units is the Ypsilanti plant. Here some 1,200 men and women make starters and

"INSPECTORS in this plant? Don't be silly. Where could you find anybody to inspect us? Any man who turns out a piece of work that isn't accurate to specifications doesn't need an inspector. He needs a job running a punch press." That's the spirit at the tiny Waterford plant where 65 men make all the precision gages used in Ford inspection. That's the spirit one doesn't find in the big mass-production plant. Waterford is a good sample of Ford decentralization—with this exception, that $10-a-day gage makers who work 50 weeks a year have little time to double as farmers

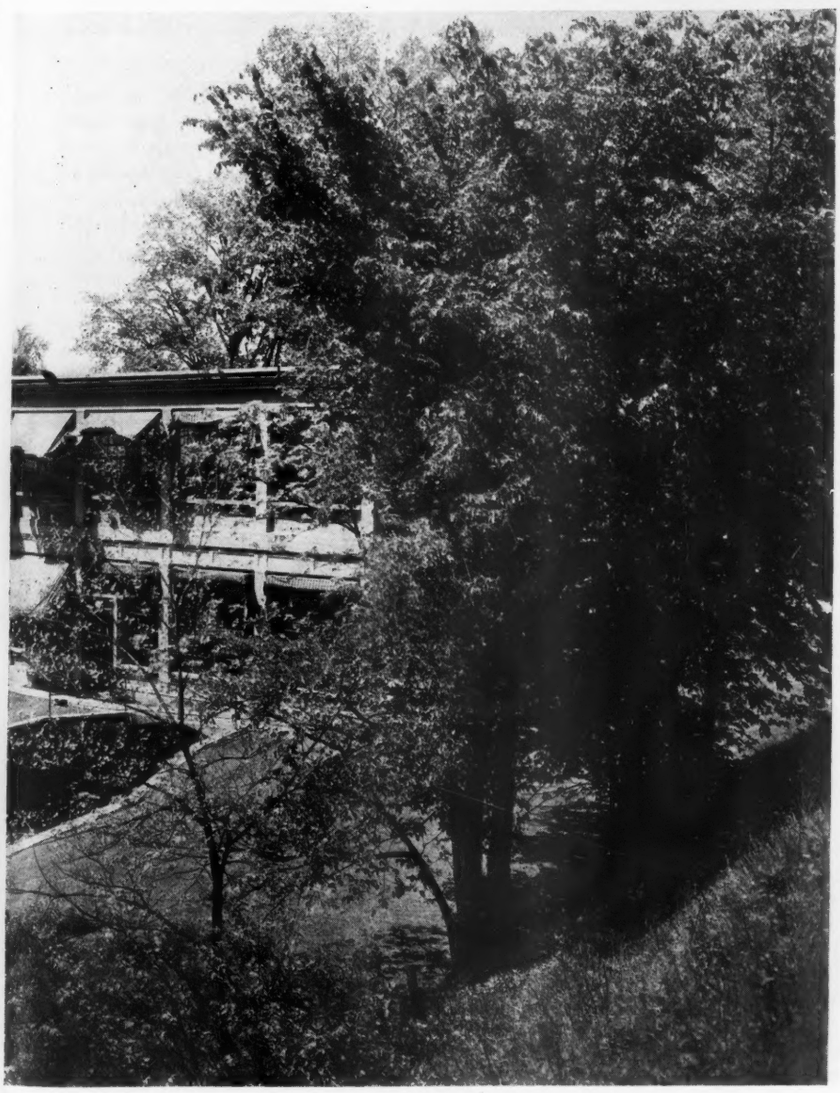
generators. It is a straight production set-up. Almost all jobs are machine-tending or conveyorized assembling at the minimum Ford wage of $6 a day—which applies to the women in the plant as well as to the men.

Some Bright Hunches

As you go through Ypsilanti, you may observe various operations differing from anything you have ever seen. For example, commutator slots used to be sawed into the copper separately; now all are made at once with a multiple broaching operation.

On the coil-winding some ingenious little clips, first cousin to those the time-study man uses to hold his sheets, take the place of the ordinary string for temporary holding. The guide tells where these improvements came from. Almost without exception, he says:

"That boy over on the job thought of it himself, so we turned the hunch over to a machine tool company and they worked it out." Or, "It looked like a good idea when the winding-machine operator figured it out, so we made up a few in our machine shop and they stepped up our production from 60 to 80 an hour."



Of course, machine hands in great big plants occasionally get some bright hunches, too—but I never have seen so many homespun developments in any other shop of the same size.

Why? You cannot put your finger on any exact reason. A number of influences contribute. First, the wage earner who comes to a plant in an agricultural community is a higher average type, has more background of thinking for himself than the average of the city streets. He naturally wants to contribute to the general welfare.

Such Jobs Are Scarce

Second, the job means a lot a more to a farm boy or small-town workman, for a town like Ypsilanti offers no overplus of $6-a-day jobs, and the fellow who appreciates his job is likely to think about it more seriously.

Third, if you get a good idea, it is not dwarfed by the magnitude of your surroundings and never heard of outside your own department. Instead, folks point you out at the movies.

So far, so good. But it costs just as much to lay down raw stock at Ypsilanti as at the Rouge. Freight costs on finished parts to branch plants are the same. And there are many freight cars and trucks going daily across the intervening 26 miles for deliveries of

Biggest of the small Ford plants is Ypsilanti. These oldsters who are assembling motor-generator sets average well above 60 years of age. A large share of Ypsilanti's 1,200 employees are as much farmers as they are factory hands

•

starters and generators to be used at Rouge. Where is this extra expense made up?

"In lower supervisory costs," answers any supervisor in the plant. All these folks require is to be shown how a job is done, and then an occasional visit to make sure they have not lost the knack. Beyond this, they ask nothing better than that the boss go away and let them do it. They are self-reliant, interested, proud of being an important part of this fine, high-paying plant.

One Foot on the Soil

Waterford is hardly a fair sample of Henry Ford's idea of one foot in industry and one on the soil, because gage-makers cannot afford to farm with $10 time. Their skill is so rare, too, that they are kept working 50 weeks a year, with 2 weeks' layoff as summer vacation. But at Ypsilanti a large share of the employees are as much farmers as they are factory hands. Dozens take leave of absence as soon as the soil can be worked in spring, return after harvest. Scores more take shorter layoffs to help with sowing and threshing peaks.

Rule 1 at all the small plants is that any man may leave at any time to work on the farm, may have his job back—barring shutdowns — when he gets through farming. Some few of these requests come at times of heavy factory schedules in early spring. But most farm furloughs are at full periods, doubtless relieve the management of other layoffs.

A man laid off in an industrial city is condemned to idleness and lost income unless he finds another job. In the country he always has enough postponed farm work to keep him profitably busy as long as he is off—and if the shutdown should be long, he has his land to support him. The city employee may not always be found after layoff, or may be in another job he wants to keep. The farmer-worker has his roots down, is there when the shop reopens.

Nobody in the Ford organization believes that centralized manufacturing is in its twilight. Obviously there has as yet appeared no other production tool that threatens to take the place of the big mass-production plant for heavy parts or parts involving very little work. But the small plant as worked in the Ford Motor Company has demonstrated great possibilities of advantage for the small, light, easily transportable articles that acquire a good deal of time and added value in manufacture. The value added by manufacture must be comparatively high to justify hauling 30 or 50 miles each way.

Henry Ford believes from experience that big organizations are necessary to mass production and that heavy work cannot economically be decentralized. But he has proved that work that lends itself to decentralization is done better in small plants where everybody from manager to sweeper can concentrate on the specialized problem and be free of the turmoil inseparable from large-scale manufacture.

His small plants were established and are being added to every year because they are economically justified. They do better work at lower cost. Everyone, employer and employee, is better off, in money and otherwise.

Sane Atmosphere

Social benefits, Ford asserts, are merely the byproducts of efficient business management. But even as a by-product it is important to give people an opportunity for greater self-generated security than the industrial cities can give. It is important to let people live in the steady, sane atmosphere of the countryside, away from the ills and isms of the more congested areas.

Beyond all room for argument, Ford has proved that the decentralization program is practical. It is high time, therefore, that other manufacturers try out the idea for their own selfish good and for the national welfare. If they go at it as carefully and skillfully, in a few years there will be hundreds of village industries throughout the industrial states. And the central factories of mass production will be all the more productive and efficient for having simplified their big jobs by moving so many of the little operations away.

Foremen on the Balance Sheet

Foremen are hidden or intangible assets—when they aren't liabilities

JOHN RICHELSEN
Personnel Director
Vanadium Corporation of America
Niagara Falls, N. Y.

WE'VE ALL heard about hidden assets and hidden liabilities in a company's balance sheet. No company statement can tell all the truth about its assets and liabilities. Even the officers, unless they are exceptionally close to their working forces, may not have complete knowledge of all the plus and minus values in the business. And many a company has taken a sudden sock on the chin because it didn't know it owned such things as hidden liabilities.

Every company, even the most conservative, has these assets and liabilities. They are not evident at first glance. They are what might be called intangibles—items that can't be seen, and quite impossible to translate into cold, hard dollars and cents.

Foremen are a part of the hidden or intangible assets and liabilities of a company. No accurate knowledge of a company's condition, especially of its future prospects, can be gained without some definite information about its group of foremen. Foremen constitute an important section of plant personnel. Edward R. Stettinius, Jr., recently said: "Men, the prime necessity and supreme asset of any business, are rarely evaluated among its assets." Of course he was referring to foremen and other key men valuable to a company.

It can just as well be said that men may be the supreme liability of any business and are rarely evaluated among its liabilities. Foremen, themselves, it may be confidently maintained, know the truth of these assertions better than anyone else. But how can you state in an inventory the liability of your poor foremen or, for that matter, the asset of your good ones?

For Good or Bad

How important are the foremen on the true balance sheet of a company? A group of loyal, aggressive, and progressive foremen is an asset that may be a more important factor in the future prosperity of a company than many of the items listed on a financial statement. Foremen "on their toes" can whip a lot of the difficulties always besetting production. A group of poor foremen can do irreparable damage to their company, no matter what market, equipment, and financial advantages that company may have. It isn't rare, sabotaging foremen we are thinking about, because it is easy enough to spot and get rid of them. But we are thinking of the foremen who fall down on the job and fail to accomplish what they ought to for the company.

Anyone who has worked on the inside of a business, and not merely studied figures on paper in an investment office, knows how much the human element counts for good or bad in a company's set-up. Indifference, quarrelsomeness, poor supervision, laxity in safety practices, lack of cooperation between departments (especially on account of jealousies and other personal factors), and other such considerations largely in the hands of foremen, are vital matters in the present and future condition of a company.

If an investor can read the foremen's palms in this way, together with the available information about the tangibles, he can tell whether or not it is wise to buy the company's securities, or better to sing, "No, no, a thousand times no."

It must be kept clearly in mind that although they don't appear there, foremen should be reckoned in a balance sheet. The character of its foremen is a big item in evaluating the true condition of any company.

Laid Out to Handle More

It's goodbye to backtracking and needless handling, thanks to conveyors, a new building, and carefully made plans

G. V. POLLARD

Works Manager
Kelvinator Division
Nash-Kelvinator Corporation, Detroit

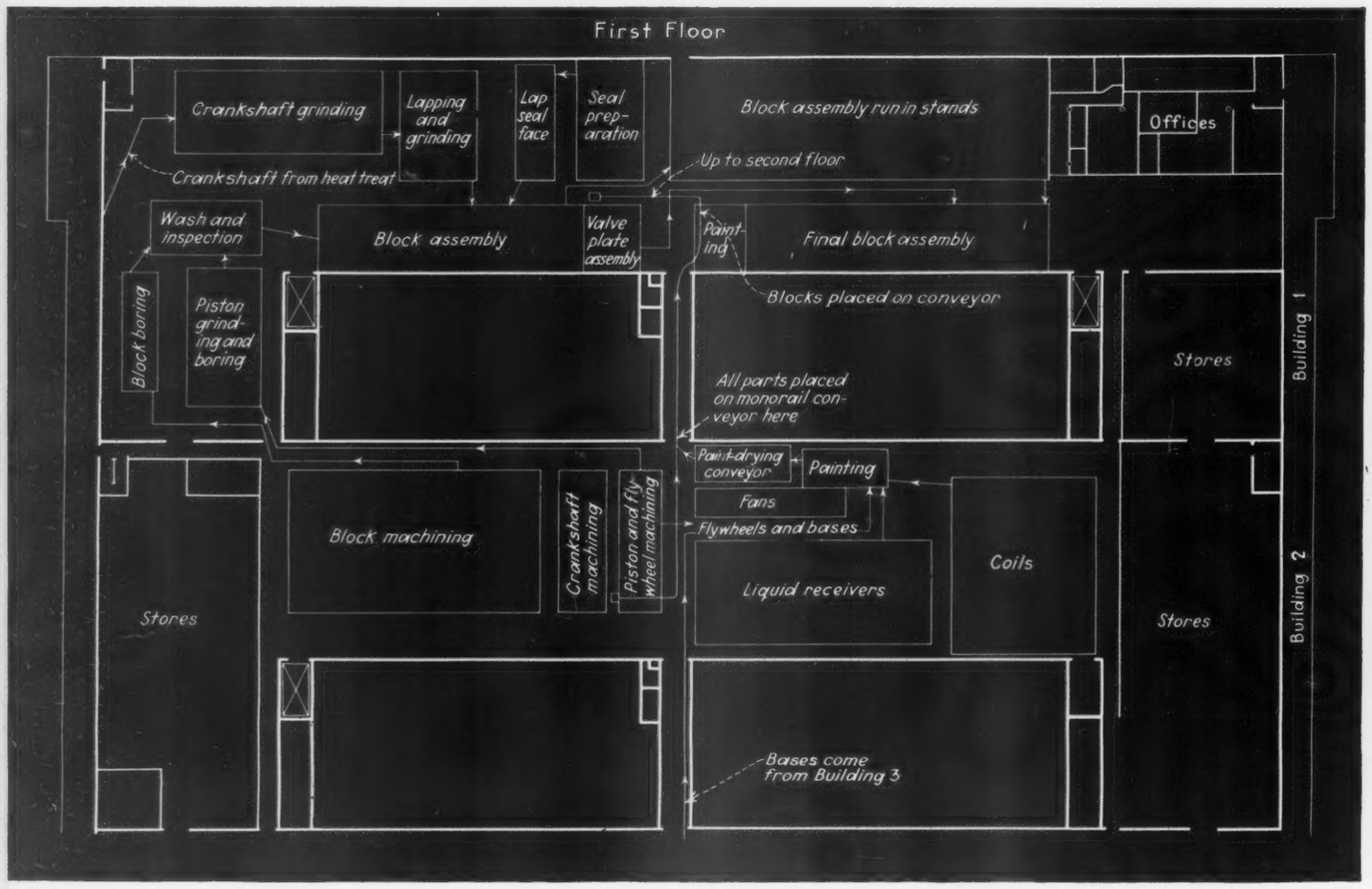
AFTER TWO YEARS of intensive study we entirely revised our plant layout. While the inconvenience and excess costs of the old plan were obvious to the management, actual change had to await increased business in the domestic refrigerator line, and in commercial and air-conditioning units, beyond the capacity of the old layout.

For several years the corporation has followed the policy of building in the slack sales season and storing in anticipation of the spring and summer sales peak. By this means operations are maintained fairly level and employees are given more nearly continuous employment than if production accurately follows the sales curve.

Until the beginning of this year completed units were stored in rented warehouses about the city. When it was decided to make changes, first step was construction of a warehouse as an integral part of the factory. This move, together with a new two-story building connecting factory and warehouse, added 294,000 sq.ft. of floor space to the existing plant. By shifting final assembly and crating lines to the second floor of this new building, and using the first floor for export crating, space was provided to take care of rapidly expanding air-conditioning business and increased production of domestic refrigerator units.

Revisions in layout with a single-floor building are comparatively easy; with a multi-story building, on the other hand, it is quite another story. Our main building has three manufacturing floors. These floors, however, are not continuous. Eight open courts provide maximum natural light in manufacturing departments, but make straight-line flow difficult to achieve.

A further factor, although not as irksome from a layout standpoint as the first, is the necessity of segregating series of operations in special rooms apart from other manufacturing operations. This must be done to reduce vibration, thus insuring accuracy, and to guard against the possibility of dust or other foreign material getting into the compressor unit during assembly. These provisions hold



for diamond boring of cylinders, cranks, connecting rods, and pistons; the lapping of these parts; the assembly of the valve plate and seal and the cylinder block assembly. Motors on the diamond boring machines, for example, are mounted separately to reduce vibration. Selective fits are used on all moving parts of the compressor, necessitating extreme accuracy.

The problem then was to adapt straight-line flow to precision manufacturing, despite difficulties inherent in the shape of the building and the character of the operations.

It Was All So Obvious

Crowded conditions of the old layout, and the excessive trucking involved, were so obvious to us that no process-chart analysis was needed. While some improvement could have been made prior to construction of the two-story final-assembly and crating building, it was decided to make all changes at one time and avoid expensive changes later, when the new building was available. This backtracking and excessive trucking was due to expansions in the various lines and to changes made in methods of manufacture.

Excessive trucking in the old plan is best indicated by the following examples: The wire harness to connect up the unit for operation, as well as small parts such as doors and trays used in the cooler, were assembled on the second floor of Building 5, and had to be trucked to the final assembly line in Building 2, a distance of several hundred feet. The revision places this sub-assembly beside the final assembly line immediately adjacent to its point of use, eliminating trucking entirely.

The compressor block used to be machined on the first floor, Building 2, then moved to floor two for assembly, back to the first floor for a run-in test, and then after being completely assembled, went back to the second floor to be assembled in the box. This involved three elevator movements as well as considerable horizontal trucking.

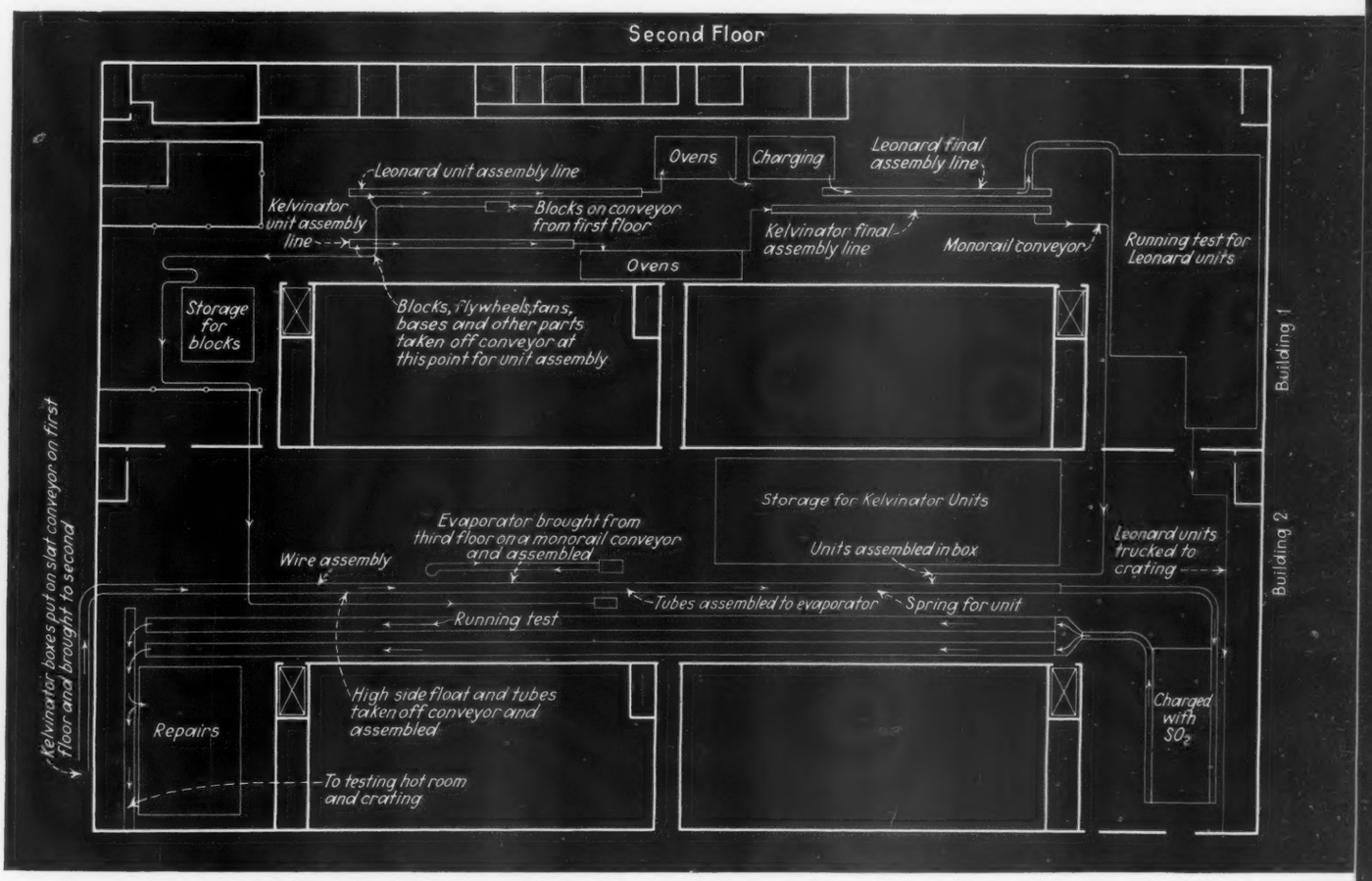
Next to the change made in final assembly and in crating the change in compressor manufacturing is perhaps the most significant. The various parts were made in departments scattered over the three floors of the plant. Coils were formed on the third floor, valves machined on the first floor of Building 5, small parts assembled on the second floor of Building 5, and the compressor block moved between the first and second floor of the building as just shown.

A section of the building drawing showing the first and second floors of Buildings 1 and 2 indicates the very considerable reduction in backtracking and trucking under the new plan. Machining of all compressor parts and the forming of all coils and liquid receivers, formerly done on the third floor, are now on the first floor. Coils, liquid receivers, flywheels, and bases are painted within a few feet of where they are made, run over the air-drying conveyor, and move by overhead monorail conveyor to the second floor unit assembly just above.

No Elevator Ride

Pistons, blocks, crankshafts, connecting rods, and seals are machined, diamond bored, bearingized, and lapped on the first floor of Buildings 1 and 2, and in a straight-line flow. When these parts are machined they go at once into the block assembly, then across the aisle to the block test—no elevator ride this time. Following the run-in test these units are assembled to form the compressor which is painted and air dried, winding up at the same overhead conveyor just mentioned within a few feet of where the coils, bases, liquid receivers, and flywheels are attached to it.

This overhead conveyor connects with


Second Floor
Leonard unit assembly line
Ovens
Charging
Leonard final assembly line
Kelvinator unit assembly line
Blocks on conveyor from first floor
Kelvinator final assembly line
Monorail conveyor
Running test for Leonard units
Ovens
Storage for blocks
Blocks, flywheels, fans, bases and other parts taken off conveyor at this point for unit assembly
Building 1
Kelvinator boxes put on slat conveyor on first floor and brought to second
Storage for Kelvinator Units
Evaporator brought from third floor on a monorail conveyor and assembled
Wire assembly
Units assembled in box
Leonard units trucked to crating
Building 2
Tubes assembled to evaporator
Spring for unit
Running test
High side float and tubes taken off conveyor and assembled
Repairs
Charged with SO_2
To testing hot room and crating

the beginning of the unit assembly conveyors on the second floor, one for the Leonard Unit and one for the Kelvinator. The first operators remove as many parts from the conveyor as needed, any excess being carried to a storage room immediately adjacent.

From the end of the unit assembly line a second overhead conveyor takes units to the point where they are assembled in the box. This takes place on the same floor of Building 2. Removal of minor assembly jobs, such as cooler trays, doors, and so on, as well as final crating, from this location to the new building, relieved congestion and permitted a more satisfactory layout of these assembly operations.

A Run in the Hot Room

After the unit is assembled in the box, a running test, carried out on a slat conveyor, and a several-hour run in the hot room await each unit before it is ready for crating and shipping.

At this point the new building connecting manufacturing departments with the warehouse comes into the picture. Two slat conveyor lines run from the hot test room through the second floor of this building to an incline leading to the warehouse. One of these conveyors is used for the final assembly of minor parts, for final inspection of domestic refrigerators, and for crating and marking.

The second serves the same purpose for all commercial units, such as water-coolers, ice cream cabinets, and air-conditioning units. These units are assembled on the second floor in buildings at right angles to the travel of the crating conveyors. Layout changes made in these departments were based on the same principles introduced in Buildings 1 and 2.

The slat conveyor, declined 10 degrees, moves boxes in an upright position to the warehouse floor. Four gasoline elevating trucks take boxes from this conveyor and deliver them to the proper storage positions. Boxes for foreign shipments are delivered by these trucks to the foreign crating department on the first floor of the new building, which is only a few feet from the end of the incline.

From 800 Feet to 25

Here was a spectacular improvement; in the old layout foreign boxes had to be trucked by hand from the west side to export crating on the extreme east side of the plant, and then back again to the conveyor leading to the shipping department on the first floor, a distance of some 800 feet. This distance is now reduced to about 25 feet.

Straightline layout can be achieved in a multi-story building by the use of conveyors. The efficiency of our present layout is due in considerable measure to conveyors introduced to form the connecting links between operations necessarily performed on different floors. The overhead monorail conveyor leading from the parts machining and compressor assembly on the first floor to the unit assembly on the second has been mentioned, as has that from end of the unit assembly to the box assembly, also on the second floor. Once the unit is put into the box, slat conveyors carry it the rest of the way.

The box into which the refrigerating unit is assembled is made in our Grand Rapids plant. It is received by rail, placed on a slat conveyor inclined 10 degrees and elevated to the second floor assembly in an upright position. It is not removed from conveyor until ready for shipment. Under the old plan the boxes were placed on their sides, elevated to the second floor, and again raised to the upright position required for assembly. Two needless operations were eliminated by this inclined conveyor which, by the way, is a duplicate of that provided for lowering the completed refrigerators to the warehouse floor.

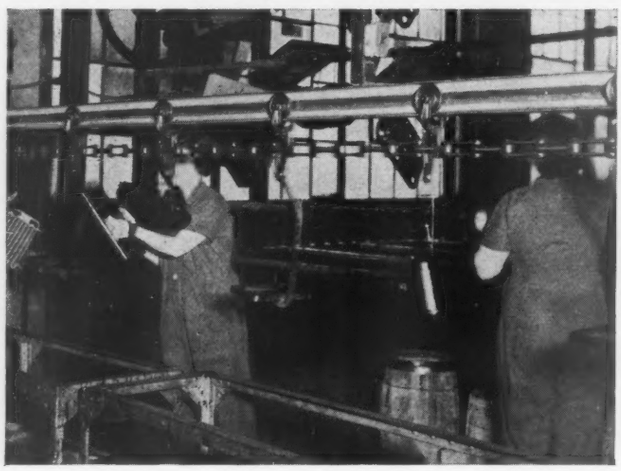
Experience with this revised layout shows that we have eliminated a number of heavy lifting and trucking operations for our employees, and made their work easier by the substitution of mechanical handling. Process time has been reduced by a better coordination of operations; operators are not delayed by failure of material supply from distant departments under different supervision, because parts are now made adjacent to where they will be used.

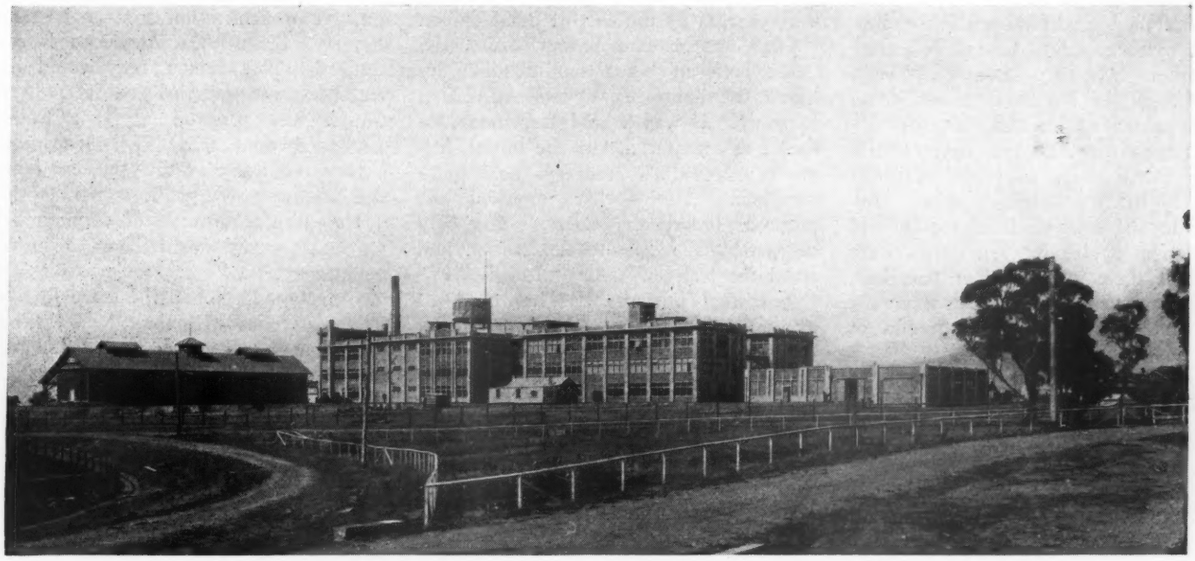
One Man Responsible

A noticeable result comes from improved supervision. For example, the seal, which operates against a machined surface on the crankshaft to prevent escape of the refrigerant, is a very important part of any refrigerating unit, and is finished to optical flat limits. Under the old plan the many intricate and precise operations required on this part were under the supervision of four different foremen, and rejections under the optical flat test were from 3 to 5 per cent. Now one supervisor is responsible and rejections are negligible.

Running back and forth between departments for consultation has been eliminated; one man is responsible for machining the seal and for the crank face against which it must operate. Finally, with properly coordinated departments, little storage of parts between them is necessary, and congestion with attendant inconvenience and inefficiencies has been relieved.

Conveyorized assembly is the smooth job it is because the monorail brings parts almost to assembler's elbow





Not so different, this modern Australian factory, from many a plant on our own industrial scene

Has the Millennium Arrived in Australia?

No, says Mr. Mehren in this conclusion to his searching analysis of her experience with the advanced type of labor legislation we are just beginning to sample

EDWARD J. MEHREN
Formerly Vice-President
McGraw-Hill Publishing Company

AMERICAN labor leaders fear that arbitration would take away from them their strongest weapon, the strike. It is clear that this has not happened in Australia. Strikes in advance of Court hearings are not illegal, and in the case where they are (refusal to accept an award), enforcement—that is, compelled employment—has not, and, for obvious reasons will not, be attempted.

In sum, Australia's arbitration cannot very well be termed compulsory, though that work is commonly used. Such compulsion as exists runs against the employer.

Employers' Questions. But, asks the American employer, hasn't arbitration ranged workers and employers into opposing camps, destroyed the man-to-man confidence essential for continuing peaceful labor relations? The answer for Australia is the same as it is for New Zealand (*Factory*, February, 1938). The system has not thrown a cleavage between employer and employed. Just as close relations can be cultivated under this system as without it. If this were not true, production bonus and wage dividend plans could not be successfully installed and carried on.

True, negotiation is between employer and union official, but that does not seem to worry nor embitter the employer. He states that the union leader is in a tight place and that to hold his position he must constantly be seeking new concessions for his men. Nevertheless. he testifies that in all but rare cases the union officials are decent, responsible men.

Grafting and racketeering, if they do occur, are rare. If at times union secretaries make unreasonable demands, fairness can be made to prevail, so the employers say, if the facts can be put before a committee of the workers. Nowhere did I encounter that vehement criticisms of unions so frequently met with in America. A high degree of unionization is accepted here as normal.

Also, the American employer wants to know whether arbitration has imposed the closed shop on Australian industry. No, it has not. Unions have repeatedly asked for its Australian equivalent, exclusive union preference, but what they have got is "union preference, all things being equal." That clause allows the employer to hire non-union men. In many plants they promptly join the

union, often on the advice of the employer, in order to escape the pressure to which they might otherwise be subjected. Other plants have a minority of workers who are union members, even though the unions in those plants are the agencies for getting awards.

As to efficiency, all employers testify to the intelligence, diligence, and efficiency of the Australian workers. Access to legally supervised arbitration and the receipt of legally set wages have not made them indifferent or truculent. Building contractors, by the way, say that even in flush times restriction of output is negligible.

Depression Test. Australian employers say that the best evidence of the value of the system is the fact that it weathered the depression. Between the time of the World War, when arbitration really became well established, and the beginning of the depression, wage rates had been raised steadily on account of the increase in the cost of living. Trouble was not to be anticipated under those conditions. But what would happen when the cost of living fell and the basic wage automatically followed? That was the question frequently put.

Then came the test. The basic wage and all award wages tied to it fell with the cost of living. But, in addition, the Federal Arbitration Court, looking to the heavy shrinkage of the national income and the seriousness of the financial situation, actually decreased wages 10 per cent below the point to which they were carried by the cost of living index.

That was a contribution which the Court believed labor should make towards the balancing of the Australian economy. It was a bold step, one now hailed as a material, and the initial, factor in Australia's recovery, now quite complete. The workers opposed this proposal before the Court. *But they accepted the decision.* Arbitration had stood the test.

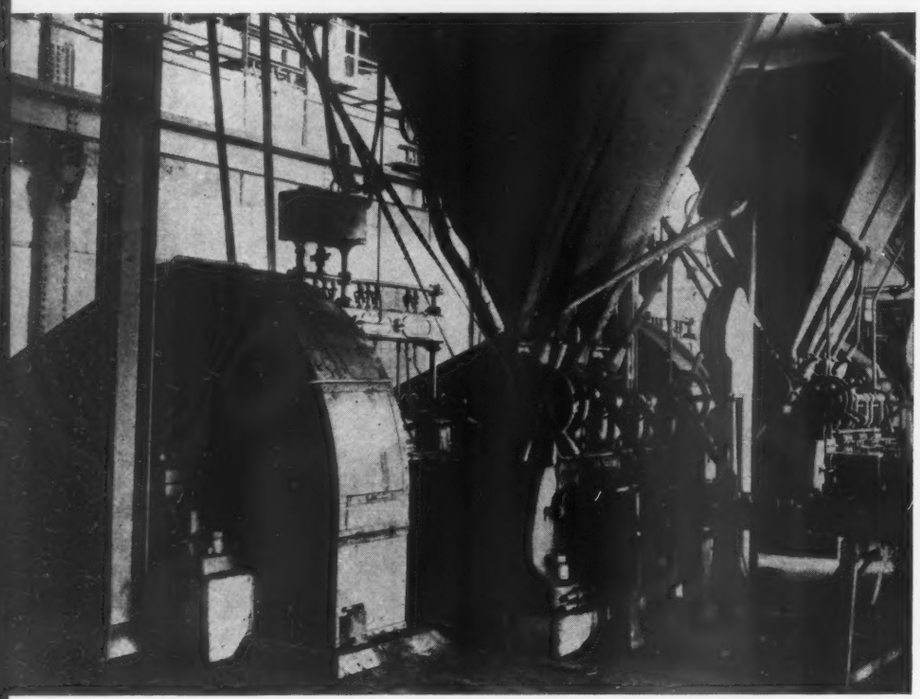
Now that business has improved all of the severe cuts of 10 per cent have been restored by a succession of increases, partly by the adoption of a new cost of living index. Of course, the basic wage has also risen with the cost of living.

Some readers will recall previous reports on Australian arbitration, notably one made by a group of American manufacturers who were here early in 1914. They reported that arbitration was giving no end of difficulty and that we had better avoid it if possible. The facts were correctly reported, even though the conclusion was not necessarily sound. Arbitration was then in its infancy. It was having growing pains. It was not satisfactory to any one of the three parties affected. Australia was exploring, as Justice Higgins, an early president of the Federal Arbitration Court expressed it, "a new province for law and order," and the ordering of that province was beset by many difficulties.

Today the situation is radically different. The arbitration system is fairly mature. Should the American investigators of 1914 return, they would find that the growing pains are over. Arbitration has survived a great test—a severe economic crisis. All three major parties at interest—the public, labor, and employers—say, "It works."

The present attitude of employers is particularly significant because in the beginning they opposed arbitration vigorously. They had the same fears of its interference with their businesses as American employers have today. Now they have found that it does not interfere seriously, but actually proves a protection against those chiselers in their own ranks who would cut prices if allowed to underpay their workers. Advantages outweigh disadvantages.

On one point—life tenure of judges—employers are quite emphatic—that arbitration will not work with an elected judiciary or board nor with one subject to political change. In the final courts —Commonwealth and state—the judges must have the qualifications of supreme court justices and are appointed for life. Further, there is a strong tradition of judicial impartiality in Australia. No matter by what party appointed, a judge promptly divests himself of party prejudice. In consequence the judiciary is very highly respected. Upon this cornerstone of life tenure and consequent impartiality, so the employers contend, rests the Australian system.



In this Yallourn (Victoria) plant, electrically driven triple presses produce briquettes for use in mechanical stokers

Judges for Life

Americans operating plants here share the same view as Australians and insist that arbitration could not succeed in America unless the ultimate industrial tribunal were composed of judges appointed for life and thus above the reach of party influence.

The necessity for impartiality holds also for success in conciliation committees and wage boards, but here the experiences differ in different states. When the chairman of conciliation committees had a vote in New South Wales (they do not have it now), their position, it is claimed by employers, was strongly colored by their political affiliations.

On the other hand, Victorian employers *and employees* are quite well satisfied with the operation of their wage boards, in which the chairman *do* have a vote. These chairmen are chosen from a standing panel (added to from time to time). Employer and employee appointees to a wage board agree, if they can, on a chairman from this panel. If they can't, they indicate those to whom they object. The Minister of Labor then appoints a

chairman from the panel but may not appoint anyone to whom objection has been raised.

The personnel of the wage boards is subject to review annually, and a chairman may be displaced if objected to by either party. Many chairmen have presided over their respective boards for many years, and chairmen with a reputation for fairness and ability are sought after. Some of them preside over 20 or 30 boards. Apparently the position has been dignified by a professional conception. This is due partly to the fact that a "determination" of a wage board, when approved by the Governor-in-Council, as all determinations are, becomes law.

A caution. American employers coming here to study arbitration need to dispel two American conceptions if they are quickly to comprehend the Australian system and its results. We—or many of us—feel that unions are not a normal element in industry, that they are interlopers to be resisted. Here unions are accepted as a necessary and an integral part of industrial life. In fact, an assumption basic to the system is that the two parties shall be organized and that negotiations and arbitration shall be between groups.

Week In, Week Out

Second, we resort to arbitration only for the settlement of serious disputes. Therefore we are apt to look on the Australian system solely as a means of composing industrial warfare. We are likely to focus attention on the Court, to the neglect of private negotiation and conciliation. Therein we would be in error. The term "arbitration," although strictly applicable only to the final tribunal, is widely used here to include the entire system.

To put it in another way, the system is not one that is kept handy for use only at rare intervals, but is the normal week-in and week-out mechanism for handling not only major issues but also all the minor questions that constantly occur. It is solely a referee in a bout, major or minor. It is a constantly functioning mechanism for an orderly handling of the normal items that occur in labor relations. The importance of this function will appeal to every employer who realizes that major difficulties and also lack of confidence between employer and employee spring largely from the improper, unsympathetic, and arbitrary handling of minor questions by foremen.

Millennium Not Arrived. Has, then, the millennium arrived in labor relations in Australia? Decidedly no, answer the employers. They do not quickly nor without opposition grant all requests of the employees. They declare that a free grant of all demands would burden industry, possibly to the breaking point. They maintain, too, that if they allowed labor to dictate all conditions of work—which men could be hired and which discharged—it would be impossible to conduct their plants efficiently. Consequently their opposition to unreasonable demands is firm; their cases before conciliation commissions and the courts are carefully prepared.

As to discipline, they recognize that two distinct and somewhat opposed groups cannot run an industry, that one must be the planner and director and impose a reasonable discipline on the other. Having the experience for planning and directing, the employers insist that these functions shall remain in their hands and that the employees shall submit to whatever reasonable discipline is necessary for the efficient conduct of industry. On this score, by the way, they meet no opposition from union leaders; the latter accept the principle as sound, so long as the discipline is reasonable.

Nor would the employees claim that all was perfect. In addition to their criticisms already expressed herein, they say that the judges are often too conservative, too much inclined to protect the financial position of industry.

Labor's outlook? Some comments on labor's policy and hopes may also be helpful to an understanding of the Australian situation.

Australian labor, in common with that of most of the world, takes seriously the introduction of labor-saving machinery. They believe it to be labor dispensing and are wary of it on that score. On the other hand, they know that its increasing use is inevitable and that its end effect is a higher standard of living. While, therefore, they distrust its immediate results, there is, in general, no opposition. However, there is contention that it shall not be allowed to create too much immediate unemployment. Therefore there has been a long history of efforts to shorten hours. They are now down to 44 and there is agitation for a 40-hour week.

The attitude towards piecework, time and motion studies, and all the instruments of scientific management, varies with different unions. Some welcome them, others oppose. Even when the union is unfriendly, an industry determined to adopt these methods is able to do so, particularly as to piecework, which is looked on favorably by the Federal Court.

Canning is one of the more important of Australia's manufacturing industries. Here, labeling in a Shepparton cannery

A Disturbing Objective

Australian labor's main objective, however, were it adopted by American labor, would be quite disturbing to American employers. It is definitely, and by open

(*continued on page 98*)

Bins Make the Workplace

Half the battle in light assembly work is the well-organized circular workplace. No makeshift this one. Tailor-made to fit the "one best" way

H. S. KNOWLTON
New England Editor

ELECTRIC time switch assemblies at the West Lynn works of the General Electric Company prove the value of motion study combined with compactly disposed equipment and belt-line transport. On a typical line about 75 feet long a central motor-driven belt 12 inches wide serves opposite rows of assemblers spaced from 4 to 4.5 feet apart on each side, the operators being staggered with respect to those opposite. The belt speed is adjustable between the limits of from 1 to 8 feet per minute, according to the work in progress, and the benches are each 12 inches wide. The sub-assembly operations performed on the time switch at this workplace normally require 58 seconds, and involve 20 left-hand and 20-right-hand specified movements, and 3 foot-pedal actions.

A typical set-up, Figure 1, illustrates the facilities for assembly at the operating position shown in the photograph. In the center, the fixture *"A"* holds the unit in process of assembly, with provision for pedal release as required. A screwdriver is the only tool needed.

Stock parts are carried in bins located in front of and at the right and left of the operator, these bins being of unit design, built of steel and meshing to provide the equivalent of a ma-

Figure 1. Method specification showing set-up of circular workplace for time switch sub-assembly, complete with fixture, conveniently located parts trays, foot pedal, and pre-positioned screwdriver. Emphasis here is on economy of time and motion, and every part the girl uses on the sub-assembly is positioned for least expenditure of effort. With standard steel trays or bins it becomes a relatively simple matter for the plant motion economist to arrange the workplace to suit the particular task in hand. If the job is one of short duration, the workplace is just as simply torn down. And trays and bins are ready to use another day on another job

✦

Figure 2. Here is the process chart on the same sub-assembly operations, listing the motions of both hands in proper sequence. The sub-assembly performed at this job involves 20 left-hand, 20 right-hand, and 3 foot-pedal movements

Pos. #1. & #2.
METHOD SPECIFICATION

Date

DRAWING NO.

M.S.No.

Apparatus

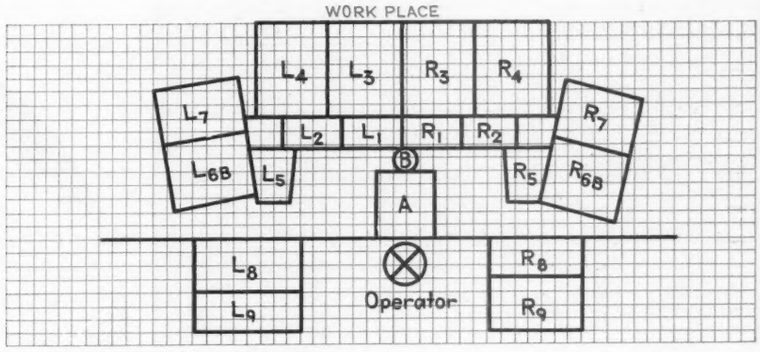
Time Study No.

Operation Assb. washer to motor, 2 set shafts, cam shaft, 2 springs, 2 sleeves, 2 gears, set hand shaft, sleeve, switch blade, backplate and 4 screws to supp. plate.

Operator

Observer

WORK PLACE



FIXTURES AND STOCK LOCATIONS:

A. Fixture
B. Yankee Screw Driver
C. Vaseline

L1. Short spacing sleeve
2. Screw 4-48 - 5/16" Rd. Hd.
3. Idler Gear Assb.
4. Assb. of set hand shaft
5. Washer
6. Setting Shaft
7. Spring
8. Field & core assb.
9. Support plate assb.

R1. Spacing sleeve (long)
2. Screw 4-48 x 1/2" Rd. Hd.
3. Minute Hand shaft assb.
4. Switch blade assb.
5. Spring
6. Set Shaft
7. Cam Assembly
8. Rotor
9. Back plate

METHOD SPECIFICATION - SEQUENCE OF MOTIONS Pos. #1 & #2.

LEFT HAND	RIGHT HAND
1. Get & pl. supp. pl. assb. L9 to A.	1. Dispose of fin. assb. A to Con.
2. Get & pl. spring on cam assb. R5 to A	2. Get & hold cam assb. R7 to A.
3. Get & pl. spring on cam shaft L7 to A	3. Hold cam assb. A
4. Assist	4. Place cam assb. in support plate in fixture A.
(Step on foot pedal)	
5. Assist	5. Wind spring on cam shaft
(Release foot pedal)	
6. Get & pl. set shaft L6 to A.	6. Get & pl. set shaft R6 to A.
7. Get washer & assb. to rotor L5 to A.	7. Get & hold rotor R8 to A.
8. Get & hold field & core assb. L8 to A.	8. Assb. rotor to field & core assb.
9. Place motor assb. on supp. pl.	9. Assist
10. Assist & throw catch on fixt. A.	10. Get & pl. switch blade R4 to A
11. Assist	11. Get & pl. backplate R9 to A.
12. Get & pl. screw L2 to A	12. Get & pl. screw L1 to A.
13. Get & pl. screw R2 to A	13. Get & pl. screw R2 to A.
14. Assist	14. Get screw driver & drive four screws B to A.
(Step on foot pedal to release assb.)	
15. Remove Switch from fixt. & lay on backplate.	15. Release scr. dr. & assist.
16. Get & pl. sleeve on set sh. R1 to A.	16. Get & pl. sleeve on set sh. R1 to A.
17. Get & hold set hand shaft L4.	17. Get & apply vaseline C to shaft.
18. Hold shaft	18. Get & pl. sleeve L1 to shaft
19. Place shaft thru supp. pl. & backplate.	19. Assist
20. Get & place idler gear assb. from L3 to A.	20. Get and place minute hand shaft assb. from R3 to A.

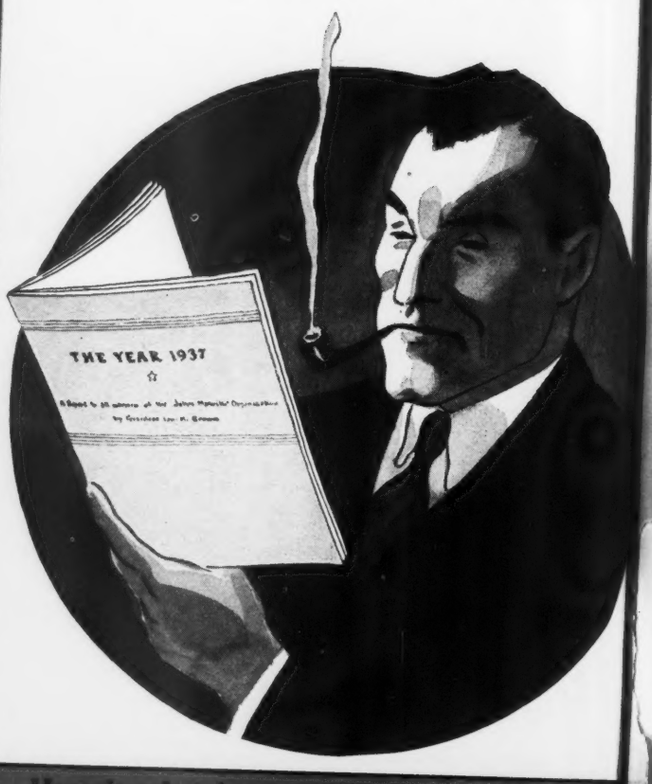
terial supply nest with open tops and ends, thus giving maximum accessibility and flexibility. A section of these bins can be dismantled, removed, and relocated without the aid of mechanics. If necessary, sections can be transported easily by truck for emptying and filling.

The bench heights normally vary from 36 to 38 inches to enable work to be done either standing or sitting.

On this line three inspection points are provided, with electrical testing facilities near the delivery end. The materials stocked in the bins and supplementary containers at the operator's position are listed in Figure 1. In Figure 2 the successive coordinated movements of the assembly cycle are given.

Each of the latter is based on time studies and measurements of motion distances radiating from the operator's position, and piecework payment is scheduled on a basis designed to insure steady production at minimum fatigue. Ordinarily the line cares for about 15 operators on each side, and assembly of two styles of switch is possible simultaneously if desirable.

J-M Reports to Its Jobholders



In 1937 We Purchased, Produced and Used the Following Raw Materials

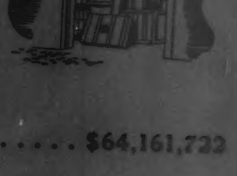
BILL FOR MATERIALS

Asbestos fibre	$2,181,611
Asphalt and flux oils	1,781,906
Packaging Materials	1,635,043
Rags and paper	1,216,225
Slates and silex	915,628
Portland cement	682,619
Wire, nails and tinplate	678,489
Cotton, sheeting, and duck	585,707
Rubber	584,960
Oxides, paints and lacquers	552,698
Felts	521,959
Coke	514,811
Slag and limestone	500,041
Hair, starches and gum	224,562
Pulpwood	200,637
Other raw materials	2,798,322
Products for resale manufactured by other companies	5,837,725
Our bill for these was	$20,311,815

A Thuse are the things we had to produce or buy in order to make them into J-M products we sold.

From these raw materials we manufactured the 1300 kinds of J-M products including-

Building Materials for Homes and Industries
Insulations
Transite Pipe and Electrical Conduit
Sound Control Materials
Filters and Filter Aids
Brake Linings
Packings and Gaskets
Asbestos Cloth and Paper
And the Many Others



We billed our customers for these in the amount of $64,161,732

Out of this we paid to the railroads, trucking concerns and others to get our products from our factories to our customers	$ 3,544,368
In addition we had to cancel sales to our customers for materials they returned to us or rejected	244,164
Subtracting raw material costs of	20,311,815
We had left	$39,861,579

B In other words this is the actual amount Johns-Manville received for the value it added by manufacturing raw materials into our finished products, and for handling certain products manufactured by other companies.

Here is what happened to the $39,861,579 which we added to the value of the raw materials and products bought for resale after they reached our plants . . . .

We paid in salaries and wages to J-M jobholders $20,154,000

To cover reduction in the value of our equipment and mineral resources because of wear and use during the year (this is called depreciation and depletion) $2,170,000

Our taxes—Federal, state and local—were $2,977,000

All other expenses including repairs and maintenance of equipment, advertising and sales promotion, telephone and light bills, rent, etc. $8,196,716

For research and development of new and improved products and processes $602,000

"Wages" paid stockholders for use of their money (these are called Dividends) $4,963,500

Put aside for new plants, additional working capital to carry on the business and for emergencies (this is called addition to surplus) $808,343

Summing up then, each of the $39,861,579 we added to the value of the raw materials and products bought for resale was divided in this way:

Wages and salaries	51 cents
Dividends	11½ cents
Depreciation and depletion	6 cents
Research	1½ cents
Addition to surplus	2 cents
Taxes	5 cent.
All other expenses	23 cents
Total	$1.00

C

STOCKHOLDERS put their *money* into the company. Jobholders put their *work* into the company. Management's chief concern is to plan for the best possible, uninterrupted annual wage or salary for both jobholder and stockholder.

There, in three short sentences, is why Johns-Manville has decided to make annual reports to both stockholders and jobholders. Its first report to the latter is just off the press; in making it J-M joins the ranks of those who have officially recognized labor as a partner in the business.

The report begins with a simple, straightforward message from the president of the company, sums up 1937's achievements on another page. And then the books of the company are opened for all to see and understand.

First, there is the $20,311,813 bill for raw materials (Exhibit A) from which 1,300 kinds of J-M products were manufactured (Exhibit B) for which customers were billed $64,161,722, of which, after paying all bills, they had $39,861,579 left. This was the actual amount J-M received for the value it added by manufacturing raw materials into finished products.

Next step shows what happened to the $39,861,579 (Exhibit C). Note how simply the facts are presented—51 cents for wages and salaries, 11½ cents for dividends, and so on.

J-M then inserts a page headed "We needed money to expand," which explains why the company sold 100,000 shares of common stock for almost $10,000,000—and where the $10,000,000 went.

Two following pages picture nine plants at which J-M products were made in 1937, and point out that the company has $4,561 invested in buildings, machinery, and tools for each jobholder.

No Mystery

Then the balance sheet as of December 31, 1937 (Exhibit D). But how different from the usual balance sheet!

The report continues with "How J-M was born and how it has grown," "J-M profits for past 10 years average 6 cents out of each dollar," "How new products are 'discovered' . . . and why these mean more jobs," "1937 was a year of achievement for jobholders," "Six thousand years of service" (in which the names of the 211 Quarter-Century Club members are listed), and "J-M products and how they are sold."

No mystery, you see. Just a case of opening up the books and interpreting the facts in language the wage earner can understand. And when you read it, you wonder why industry hasn't been doing this sort of thing right along.

BALANCE SHEET AS OF DECEMBER 31, 1937

A corporation's balance sheet always seems to be a complicated table which means little to any except financial people. But very simply, it is a statement of what we own, what we owe and what we are worth. *It has nothing to do with our sales or income or how our money was received each year and divided among employees in wages, among stockholders in dividends, etc.* It is exactly the same as if you took two sheets of paper and on one listed the cash you have, the value of your home, car, and furniture, and the dollar "Bill Jones" owes you.

On the other sheet you would list what you owe the grocer and the milkman, the amount you owe for the mortgage on your home and what you owe on your car. Then subtract what you owe from what you own. The result is what you are worth and what, in the corporation's balance sheet, is called *surplus*. This may be entirely represented by property or possibly by property and cash. This figure is placed on your second sheet. Thus the first sheet "what you own" and the second sheet "what you owe and what you are worth" *balance* exactly.

WE OWNED

We had in cash to pay wages and our bills	$ 8,670,759
Money owed to us by our dealers and other customers for products we have sold to them but for which they have not yet paid us	4,896,418
The cost of the asbestos, cement, and other raw materials which we had bought or produced and had on hand, also the value of the shingles, brake linings, and other finished products which we had ready to sell and which were stored in our factories and warehouses	9,218,793
Miscellaneous stocks and bonds which we owned	363,183
The cost of our investment in Johns-Manville Credit Corporation the company which we organized to help our customers to buy our products on the time payment plan if they have an approved credit standing	3,050,000
The cost of the land, mines and buildings in which our employees work and the machinery, tools, desks, typewriters and other property used by employees to manufacture and sell our products	49,907,367
From this we subtract an estimated loss in value of the above property because of wear and use during their lifetime	25,127,241
This leaves a value of	24,780,126
The value of premiums paid for insurance (fire and other types) and the amount of rent we have paid in advance	302,233
TOTAL amount of property, cash, and other things we owned December 31, 1937	51,281,512

WE OWED AND WE WERE WORTH

We owed for raw materials for use in our products, and for other purchases, not yet paid for	$ 1,340,245
We owed employees for wages	427,623
We owed to stockholders for dividends	131,250
We owed for U. S. and foreign income taxes	1,416,088
We owed for all other taxes Federal, state and local	553,469
We owed for insurance premiums, royalties and commissions	174,505
Estimated amount we owed for the probable cost of being self-insurers for workmen's compensation, and for the cost of replacements of products due to defective manufacture sold to our customers under guarantees	802,374
The money invested in J-M by our stockholders	40,379,898
Subtracting the above (including our stockholders investments) from what we owned (shown on the opposite page) the difference represents the worth we had accumulated December 31, 1937 in property and cash	6,056,060
TOTAL of what we owed and what we were worth December 31, 1937	51,281,512

D

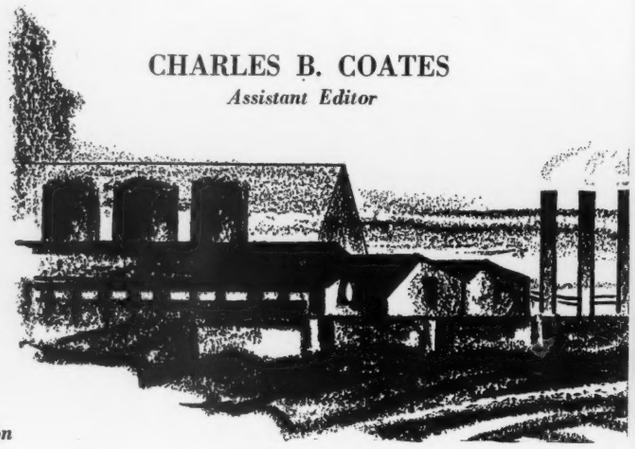
Blank & Stoller Corp.

WENDELL L. WILLKIE, *President, The Commonwealth & Southern Corporation*

Willkie WARNS

Says the man who ought to know, "If it's my baby that's hurt now, it may be your baby later on. We are simply the first target"

CHARLES B. COATES
Assistant Editor



DOES INDUSTRY as a whole face a serious threat of government ownership, competition, or control? Is the attack on public utilities only the front-line fight in a struggle that may end in the complete subjugation of all private enterprise?

Wendell L. Willkie, pacing the offices of the Commonwealth & Southern Corporation with long, determined strides, will tell you emphatically that the trend of recent court decisions in utilities cases does definitely imperil the rights of every other American industry.

"The power business is momentarily under attack, but the business man who sees no threat to his own welfare in the current utilities controversy is like the proverbial ostrich," he declares.

Fundamental issues are brought sharply into focus, Mr. Willkie contends, by two court decisions which cast a shadow over the future of all business.

"The federal government is giving away 45 per cent and lending 55 per cent of construction costs to municipalities desiring to build power distribution plants in unnecessary duplication of existing facilities," he says.

"In the legal test of this principle, the United States Supreme Court refused to intervene, saying that, although it did not pass on the constitutional right of the government to give money to any other governmental agency, the utilities company has no cause for complaint since *a city has the inherent right to compete with an existing industry.*

"The Court also ruled that our company had no monopolistic rights and that it made no difference from what source the municipalities got their money."

Now, what has that got to do with the business of manufacturing shoes and ships and sealing wax?

"Just this," says Mr. Willkie, pausing long enough to light and immediately extinguish a cigarette. He is about as restful, to talk to, as a football coach between halves and he pursues a line of thought with the same intensity. He has three speeds forward, one for listening, one for thinking, and one for talking.

"Just this—"

He resumes pacing.

"We all concede that the power business, of all businesses, is the one that tends most naturally toward monopoly. Government men and utilities men agree, generally, that utilities should be operated without duplication of facilities.

Who Will Be Next?

"If, therefore, the PWA ruling applies to the utilities, it is much more applicable to every other line of industrial endeavor; there would be no question at all of the right and propriety of government competition with manufacturers, grocers, bankers, or farmers.

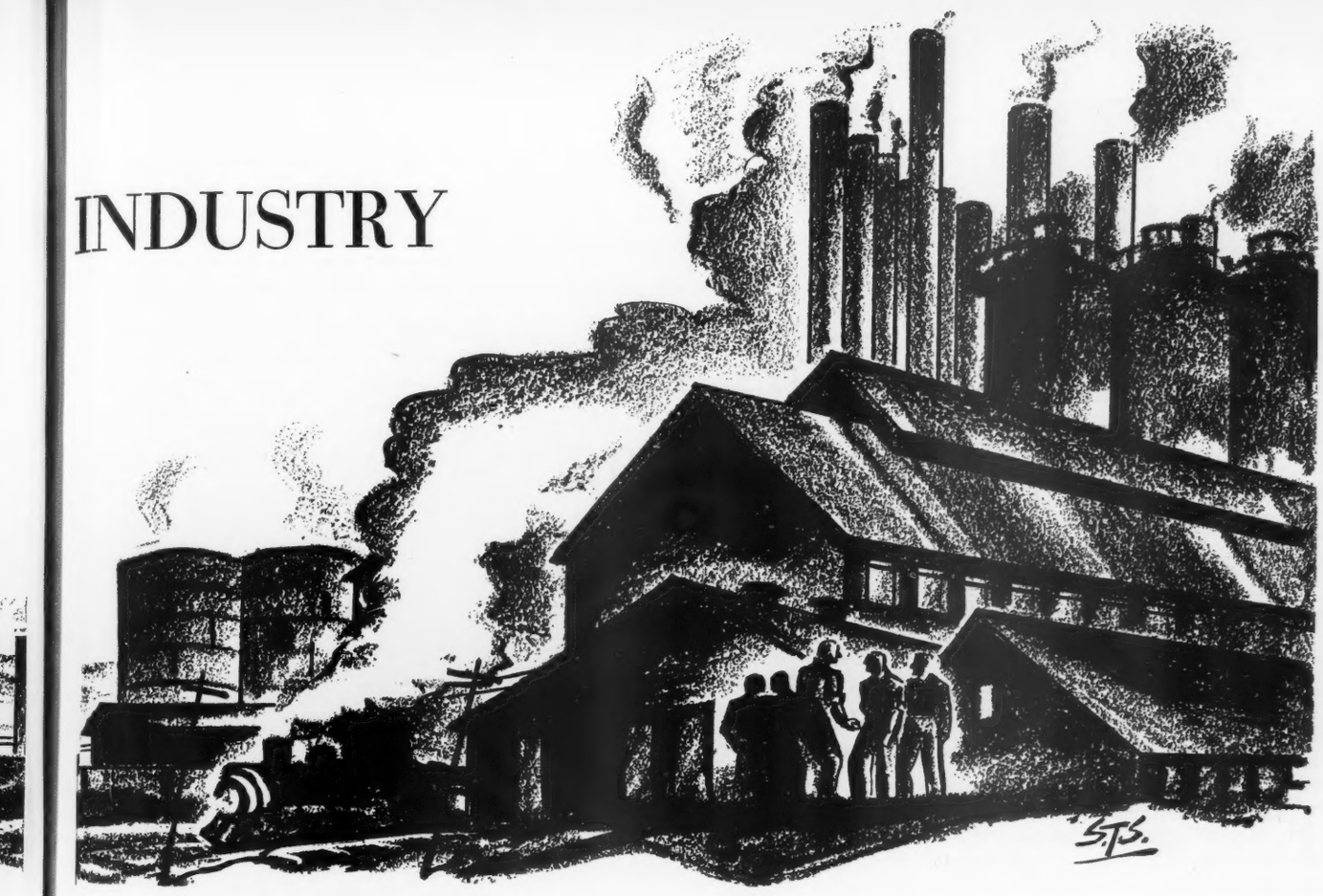
"And, if the federal government should decide to give money to a municipality to set itself up, let us say, in the hardware manufacturing business—in competition with a company already operating—then, under this ruling, the private manufacturer couldn't complain. The courts would say, as in the PWA case, that no violation of rights existed and that it would make no difference where the money to finance the new venture was obtained.

"Nor could the taxpayer complain. The relation between the money paid in by the taxpayer and the money paid out by the government is seemingly so remote and so intangible that there could be no cause of action."

Supplementing the Supreme Court case and making the danger just so much more real, says Mr. Willkie, is the recent ruling of a three-judge federal court in Chattanooga.

"Here it was decided that the utilities have no cause for complaint even though they suffer immediate, heavy loss through government competition and even though such competition may eventually bankrupt them," Mr. Willkie says.

"In other words, if, in its lawful pursuits, the government acquires property —and it may, through its various agencies, acquire anything from banks to wheat—it can sell this property in competition with private business even if that business be destroyed. And a



policy once adopted by the federal government in relation to one industry will inevitably be adopted in other lines—either when prices seem to be out of line to consumers who are not direct payers of taxes or when some particular industry is under criticism."

Many of the doubts concerning the future of Mr. Willkie's Commonwealth & Southern may be dispelled by the time this story appears in print. He spoke on the day after TVA's warring triumvirate—the Morgans, Arthur and Harcourt, and David E. Lilienthal—met in the White House for an unsuccessful airing of their unresolved disputes. They had not gathered to discuss Mr. Willkie. Nevertheless, Mr. Willkie's name came up from time to time.

This was natural. Nature appears to have had a hand in bringing Mr. Willkie, Commonwealth & Southern, and the federal government into conflict in a manner that seems almost fatal. Nature spread the kinky Tennessee River over a broad, level valley in the heart of a mightily mountainous region. Nature summoned the power pioneers of the South to the Tennessee Valley and it was just as natural that the New Deal's divining rod should snap over the same site when the federal experts set out in search of a power "yardstick." But another reason, less natural, more fatal, has become almost lost in the mists of history.

The fact is that the site of TVA's huge Wilson Dam was *given* to the federal government by a power firm which has since become part of the Commonwealth & Southern group. This happened during the World War when power and nitrates were an important national defense problem. The Alabama Power Company, now one of Commonwealth's key operating firms, stepped up and offered to donate its Muscle Shoals property to the government for the sum of one dollar. The offer was gratefully accepted and the dollar was duly paid by check.

The Tale of a Check

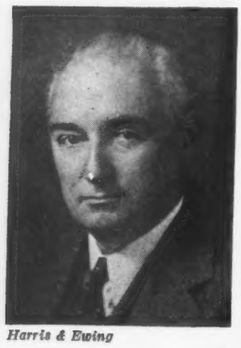
There is a wry twist to the tale of the check itself. Some time later, private enterprise, in the person of one of the company's advertising men, published a series of ads in the house organ. These ads told the story of the Muscle Shoals gift and printed a picture of the check. Then the matter was forgotten.

Forgotten, at least, until one bright March day in 1927 when two Secret Service agents stalked into the company's publicity office with papers alleging that private enterprise, in the person of an industrious Memphis counterfeiter, had made successful forgeries of U. S. Treasury checks based on the engraving shown in the house organ.

Albama Power was then led into court and fined $500 for publishing a picture of a Treasury check in violation of federal law. An additional fine of $200 was imposed on the engraving firm that made the cut. Alabama Power paid both fines. Net loss to the company—Muscle Shoals and $699.

But if fate served the utilities industry meanly in the matter of Muscle Shoals, it provided some compensation by placing Wendell L. Willkie at the helm of Commonwealth & Southern in the present crisis. Given its choice, the industry could probably have selected no abler advocate. Willkie is a native Hoosier, youngish, husky, and homespun. He has a knack of making people pay attention when he talks, as he demonstrated in his recent toe-to-toe slugfest with Robert H. Jackson in the Town Meeting of the Air. Conservatives have begun to regard him hopefully as the new White Knight of industry, the champion who may yet redeem the lorn, bedraggled damsel, Private Enterprise.

"If it's my baby that's hurt now, it may be your baby later," he concludes. "Our business simply happens to be the first target. But I have frequently said and I still maintain that you can take *any* business and, in *ex parte* proceedings, with the backing of the senatorial committee, so picture it as to create public sentiment against it."



Harris & Ewing

It's This Way in Washington

Industry can count on sharp modification of the undistributed profits tax; lots of oratory, but no "trust-busting" for the next twelve months; and no drastic change in the spending picture

CARTER FIELD
Washington Correspondent

FROM a short-range viewpoint, with respect to what the government may do, and what it will try to do, the situation in Washington is most encouraging to business in general, and manufacturers in particular. From a long-range viewpoint, the situation is much less favorable. But there is an old maxim that you mustn't worry too much about the business career of a son now in kindergarten, if you're really anxious to make a profit this year.

Moreover, all sorts of things may happen before the reefs that some profess to see in the future are reached.

So let's look first at the more immediate future, which is encouraging.

The Rosy Side of the Picture

Very important is the certain drastic modification of the undistributed earnings tax. As this is written the President is fighting to make sure of something in the pending legislation to save his face. He will probably succeed, despite the sharp drift against him, but when the bill is finally enacted the tax will be much less hampering to business. In fact it may not be a real cause of concern at all to the average manufacturer. He will certainly be able to avoid extra taxes on needed improvements, probably on new equipment, perhaps even on plant expansion.

Most corporations will have to pay just as heavy federal taxes. But if the mass of business men communicating with their representatives and senators during the last few months are painting an accurate picture, it is not the *amount* of taxes they object to so much. It is the hobbling effect of *particular* taxes, with the tax on undistributed earnings the prime offender.

Second in importance, the probability of a real raid on business in the guise of an attack on monopoly and price fixing has declined sharply. There is to be no new anti-trust legislation this session. The new trust buster at the Department of Justice really would like to do a little crusading, but he will have to take it out in talking for the next twelve months. Business men, during this clamor which may come, would do well not to worry, but to remember that sticks and stones may break their bones, but words—will never hurt them.

The true answer to this assurance that there will be no anti-trust legislation in the near future is divided in two parts. First, the brain trusters have not been able to devise a formula. They are sure they will get the answer eventually, and they are sure that when they put it on the statute books there will be no more identic bidding, down to four decimal places.

Also, the government feels it has done pretty well, so far as making a show for the public is concerned, on this monopoly business. At least for the present. It is pleased about the victory over the oil men, ludicrous as the whole business may appear to some.

Another encouraging development, for the immediate future, is that Roosevelt has not yielded to the spenders. Further, there is no immediate prospect of his yielding. For there is a school of thought among his advisers, headed by no less a figure than Marriner S. Eccles, chairman of the board of governors of the Federal Reserve System, that the government *must* spend, heavily, and immediately, or things will go to pot.

This is a controversial point. Some business men may not think it is encouraging. They may think that Eccles is right, and heavy government spending must come into the picture soon or the business picture will become worse. Others think, the more government spending, the less private spending, the less incentive to private initiative.

Whoever is right, the President has sided, for the time being at least, against the big spenders, thinks business will recover eventually without that additional pump priming.

Still another factor in the present situation which should be encouraging is that the public is getting a good look at what happens when a politically appointed board attempts to run a business institution. Regardless of the merits of the controversy between Dr. Arthur E. Morgan, on the one hand, and David E. Lilienthal and Harcourt A. Morgan, on the other, the whole mess is just another demonstration that such bodies, when appointed to perform a business job, as differentiated from performing a judicial function, do not work well.

The Shipping Board of World War memory was the last spectacular illustration of this almost unvarying rule. TVA is the present horrible example. The mess about whether to build wooden ships or steel resulted in General Goethals (who made his reputation building the Panama Canal, with no board to hamstring him, and who almost lost it in the Shipping Board) commenting "All boards are long, narrow, and wooden."

The Not-So-Rosy Side

On the long-range side the picture is not so pleasing. The debt piles up. Despite Roosevelt's violent objection to printing-press money, which is a sure guarantee for the remainder of his administration, no one can see the end in anything but inflation if Roosevelt policies are continued indefinitely.

Government reorganization is not really worrying anybody about the *present* administration, except those who dislike it. The danger is that it puts so much power in the hands of some future president, with Hitler ambitions.

Similarly, it is not the threat of government competition against presently existing business, so much, in this growth of government operation, that frightens people, as what may happen a few years hence. Which is a factor many investors weigh, but which Mr. Roosevelt does not understand when he attacks capital as being "on strike."

We Keep Fumes Away from Controls

Putting all switches, fuses, and starters in isolated rooms solved the problem of how a paint factory could best eliminate fire hazards and keep equipment clean

L. E. Du BEY
Factory Manager
Ditzler Color Company
Detroit

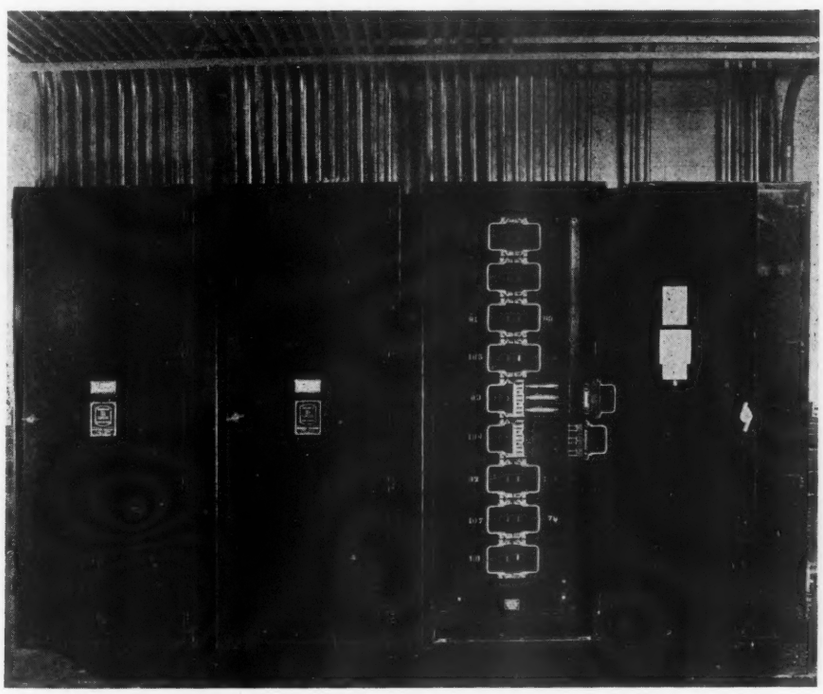
SAFETY in the operation and maintenance of all electrical and other equipment must always be uppermost in the minds of operating executives. This is true of any manufacturing plant, but particularly essential if the processes are in any way hazardous, as in our case. Solvent or paint fumes are ignitable, and one of our problems is to avoid the formation of any spark or flame that might conceivably come in contact with them.

For this reason we have adopted the practice of segregating all fuses, switches, and control equipment belonging to the secondary power distribution system in a control room in the basement or some other spot isolated from manufacturing areas. There are five of these control rooms, one for each building in the plant. Each motor in the plant has its own power panel containing the fuses and disconnect switch, and a panel for the starter.

Control rooms in turn are supplied individually by a busbar or cable leading from the main switchboard, which receives power from the main transformer bank. The reason for building five control rooms was based on balancing the cost of the cable from the main switchboard against the cost of the wiring leading to the motor-driven equipment.

Motors range from ⅛ to 50 hp. in size. They are supplied by a three-phase distribution system, part of which operates at 220 volts and the remainder at 440. Although the 440-volt equipment is somewhat more expensive, there are certain advantages in the use of this voltage, and we plan to use it eventually throughout the plant.

In addition to the matter of safety, it was of course necessary in laying out the system to give careful consideration to neatness, economy, and convenience in maintaining 100 per cent operation of the equipment. The first step was the selection of a centrally located, but isolated, place for the control room. The necessity for isolation was well illustrated by our experience with the site first chosen for the control room in the base-mixing building. It was located at first in the stairwell on the first floor. In the course of time, despite extraordinary precautions in the handling of materials, a thin film of iron oxide settled on the panel equipment, which made working with the panels hazardous. Placing the controls in a sealed room, opening only to the outside of the building, eliminated this difficulty.



Disconnect switches and fuses for the motors are grouped in panel boards like these

Conduit Tells Where Motor Is

After the location of the control rooms had been selected, it was necessary to cooperate with the production department in determining the layout of the manufacturing processes, which in turn fixed the location of the motors. On the manufacturing floors the locations of the pushbuttons for operating the motors were dictated largely by the convenience of the foremen.

With these details settled, it became evident how the conduit leading from the switches and starters had to be run out of the control rooms.

From each starter panel a conduit line runs to the corresponding motor on the manufacturing floor, in the order in which the motors are placed. Where two floors are operated from one control room, the bank of conduit serving the second floor is placed, as it leaves the control room, above that serving the first floor, and in the order in which the motors are located. This arrangement serves as an easily read classification plan similar in character to the practice of painting sprinkler piping red.

Convenience is further served by numbering the power and starter panels. If, for example, trouble is experienced with the No. 1 mixer on the second floor the electrician goes to the control room, locates this machine number on the starter panel, which also carries the number of the corresponding power panel, and is then ready to investigate the trouble;

only a few seconds are required to do this preliminary work.

When testing for trouble the electrician is amply protected. As the door of the power panel is opened to test the fuses, a disconnect switch attached to the door is automatically pulled. Opening this switch kills the line; hence there is no danger of anyone working with a live line, nor can a short circuit exist. Safety does not depend on someone's memory.

As an additional safety measure, the panel doors must be kept closed while the line is being worked upon. This may be done by removing the disconnect plug and giving it a quarter-turn to remove the copper contacts from the live part of the switch, after which the door may be shut. An indicator on the door shows the electrician when the circuit is alive.

Outlets Are Explosion-Proof

When work must be done on a power circuit, the electrician must be guarded against someone's pushing the button on the manufacturing floor. To provide this protection two holes are drilled in the starter button case so that a cotter pin, chained to the case, may be inserted over the button while work is in progress. At the same time a small sign bearing the words *Do Not Operate* is attached to the case by a clip.

A number of portable units are required on the various manufacturing floors for such service as mixing small lots of paint, or pumping liquids from one container to another. The motors and starters of these units must be placed at the machines; consequently they are of explosion-proof design. Power outlets placed at convenient locations for these units are equipped with explosion-proof fittings. Each circuit is independent and is controlled by a disconnect switch in the power line.

Outlets are so designed that the plug cannot be removed until a switch integral with the outlet is thrown, thus avoiding the possibility of a spark.

Grounding Not Left to Chance

We do not depend on the first convenient water pipe to serve as a ground. The grounding system was as carefully worked out as the circuit from the transformer to the power panel, control room, starter button, and motor. Every piece of steel framework, every line and motor, has an independent ground, and all lead to the ground system in the transformer switch room.

The transformer ground consists of a strip of copper run around the room about 3 ft. from the floor, and grounded in six places. All individual grounds from equipment and steelwork in the plant are brought down and attached to this copper ground bus. Water pipes may cease to be grounds, through subsequent changes in the piping layout, but we are sure that so long as the transformers are in place we have a permanent ground system.

In the control rooms all equipment is completely isolated from dust and fumes

Puts the Finger on Maintenance Costs

GILBERT LINDGREN
Electrical Foreman, Hudson Valley Fuel Corporation, Troy, N. Y.

IF GOOD maintenance cost records are kept, it is much easier to convince the management of the necessity of making changes. Once true maintenance costs are known, the question whether your maintenance methods are right or wrong will be answered.

To save money it is necessary to know exactly where it goes. A good starting point is the Work Order for all work done, whether routine inspection and repair or so-called extra work.

Make a list of all daily, weekly, or monthly inspections or repairs. Assign a permanent charge number to each item or group, so that all labor and material may be charged to its proper place.

Show who requested the work and why. Request an accurate estimate of the work. Whenever possible attach a sketch or drawing.

All work done on a job must be charged directly to that Work Order whether included in the original order or not. When finished, the order should show the total cost of the job against the estimated cost and the difference accounted for.

Keep the orders simple, brief, and understandable. The easier an order is to issue and carry through, the farther down the line it can be applied; the wider the scope of these orders, the more complete the check on costs.

On major repair jobs or construction work the foreman should make out all time sheets. On routine work that is done with little or no supervision, the mechanics need only mark down the number designating the particular job.

Another good plan is to have the work separated into two groups—*authorized* and *unauthorized* work. Unauthorized work includes regular inspection and repair work and also emergency jobs. These jobs are done on standing orders that are rewritten each month. Authorized work includes all work that requires the approval of some department head.

An argument often advanced against the Work Order system is that many important jobs are left undone when the management sees what a job will actually cost. There is no denying that much good has come of jobs that were railroaded through under a blanket charge, but if our true purpose is to find out what maintenance costs are, then we must find a better way to do these tough jobs that are so hard to sell to the boss.

These Drives Weren't to Blame

It's frequently the custom to assume that power drives are responsible for anything that goes wrong. Like as not, study shows they're victims rather than villains

WILLIAM STANIAR
Mechanical Power Engineer
E. I. du Pont de Nemours & Company
Wilmington, Del.

THAT THE MECHANICAL department of a plant is not always responsible for transmission equipment difficulties is proven by an experience with a cut-off clutch. Operation of two pieces of equipment from a lineshaft common to both was controlled by two friction cut-off clutches, so that the two driven units could be operated in tandem or singly. When the installation went into service trouble in the form of wobbling and jumping was experienced immediately with both clutches. One clutch would operate smoothly and concentrically, but as soon as the opposite clutch was engaged wobbling and jumping of the first one would occur.

Shafts Out of Line?

During installation it had been realized that shafts connected by cut-off clutches must be in perfect alignment and properly supported by suitable bearings. Therefore, it was immediately assumed that, regardless of construction precautions, the shafts must be out of line. Such an assumption appeared to be substantiated because when the dowel pins were removed from the bearings and the bolts loosened, one of the bearings adjacent to the clutches swung over 3/64 in. A complete check of the shaft with the clutches removed showed that the shaft and bearings were in perfect alignment. The installation was reassembled and operation resumed, but the wobbling and jumping of the clutches was still in evidence.

It was then decided to dismantle the clutches, whereupon it was found that the internal ball-bearing pilot bushings of both clutches were missing. Regardless of proper alignment of the connected shafts, it was impossible for these clutches to run true.

in the clutches, and no more trouble was experienced.

This incident shows the necessity of carefully examining all units of power transmission equipment prior to installation.

Bearing difficulties with large exhaust or supply fans are not uncommon, but occasionally the trouble is persistent and it is difficult to determine the cause. As one instance, a fan supplying hot air to a grinding operation is driven at 1,750 r.p.m. by a 150-hp., 1,160 r.p.m. motor through a flat-belt, pivoted motor base drive operating horizontally on 7-ft. centers. The layout is shown in Figure 1. The fan shaft is 3 7/16 in. in diameter at the bearings and pulley, but is shouldered down to 3 3/16 in. to accommodate the overhung impeller of the fan. The 12-in. diameter by 18-in. face driven pulley is supported between the two

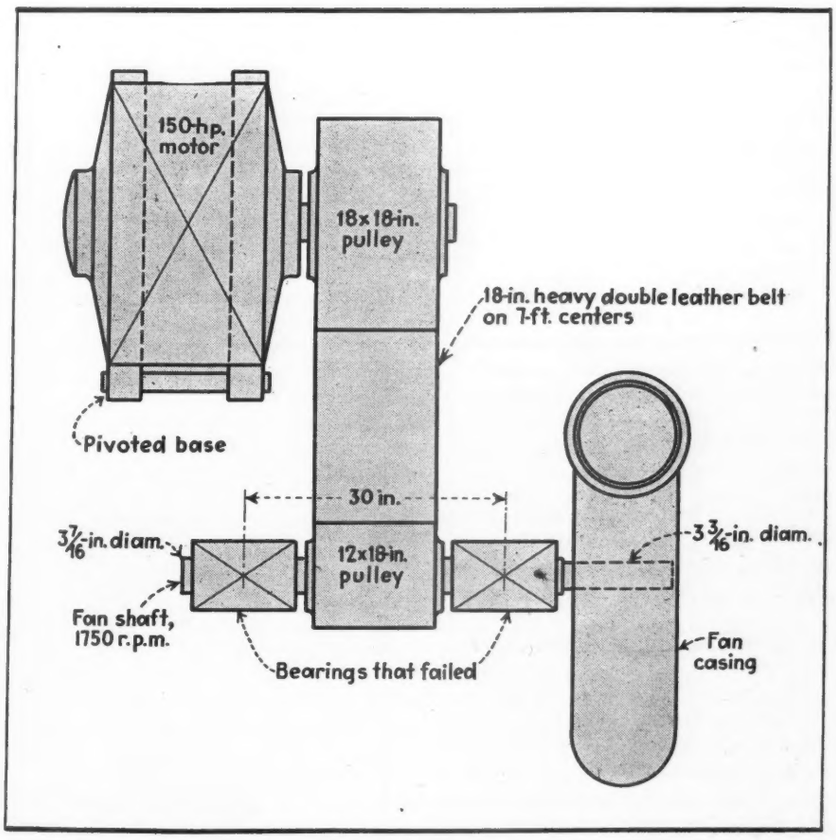


Figure 1. Increasing the speed of this fan from 1,600 r.p.m. to 1,750 r.p.m. caused sufficient vibration to destroy three sets of bearings

A pilot bearing or bushing is an essential part of such devices. It is placed in the driving hub of a cut-off clutch to compensate for any slight misalignment of the connected shafts, but if this integral part is missing perfectly aligned shafting will not prevent the clutches from running out of true. Ball-bearing pilot bushings were ordered and placed

bearings. Load on each bearing is approximately 1,800 pounds.

The initial bearing installation consisted of two high-grade, self-aligning, combined radial and thrust ball-bearing pillow blocks substantially supported on cast-iron baseplates mounted on concrete piers. In view of the high speed, heavy load, a dust-ladent atmosphere, and the

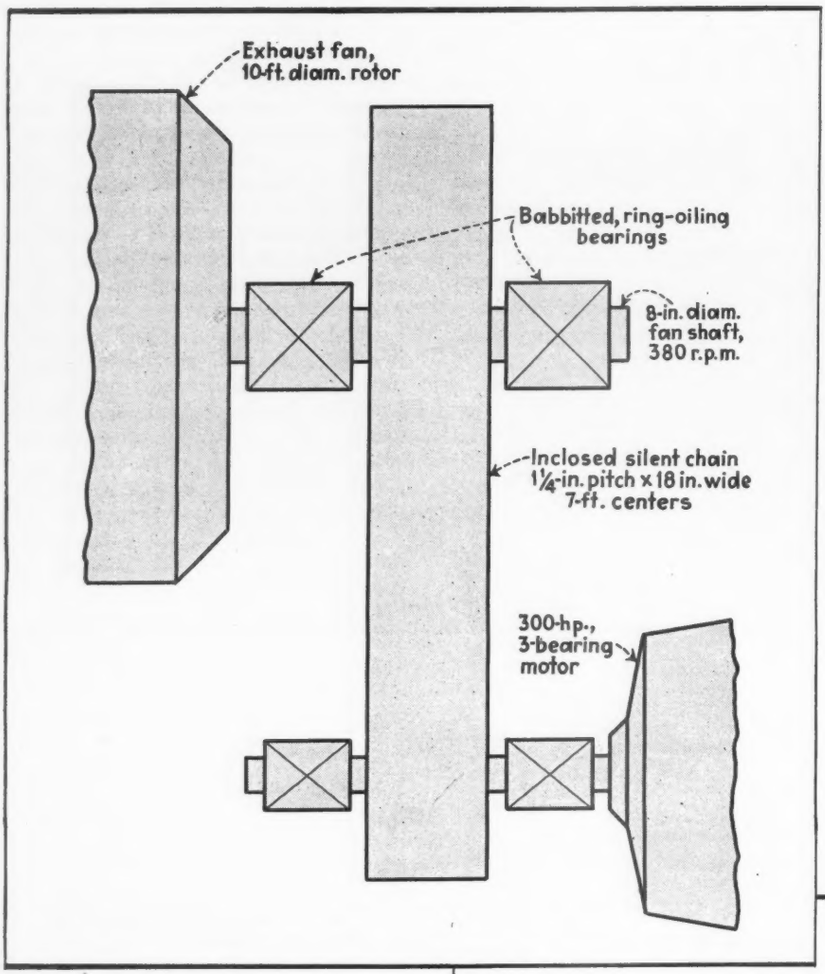


Figure 2. In this instance a damaged rotor blade caused vibration that was wrongly ascribed to the silent chain drive

possibility of heat being conducted from the fan casing, oil—controlled by constant-level lubricating devices—was employed as a lubricant instead of grease.

Bearing Failures

The first set of bearings failed after 60 days' operation, the races cracking and the balls pitting. A check was made for grit deposits in the bearings, but no such foreign material could be found. The fault was, therefore, attributed to overload and possibly excessive temperature. A second set of similar bearings was installed and upon resuming operation temperature readings were taken hourly, the highest being 196 deg. F. The manufacturer of the bearings advised that 300 deg. F. was the danger point.

This set failed after approximately 70 days of operation, but in addition to cracked races and pitted balls, the base of the lower half of one bearing housing broke off at the bolt hole. It was then decided to replace the ball bearings with the spherical-roller type. This was done and within 60 days failure of these bearings occurred.

The manufacturers of the spherical-roller bearings suggested that possibly the impeller of the fan was out of balance and, due to its diameter of 6 ft. and high speed, was creating vibratory reactions on the bearings. Upon testing the impeller for dynamic balance, it was found to be 1 oz. out. This amount is within industrial tolerance for an impeller of this size, and therefore it was not likely to be the cause of bearing failure.

In view of the importance of this fan installation a meeting of all parties concerned was called, since it was obvious that some hidden cause was responsible for the bearing failures. It was eventually brought out that the speed of the fan had been increased from 1,600 r.p.m., as specified by the manufacturer, to 1,750 because of unforeseen plant requirements. This increase in speed of

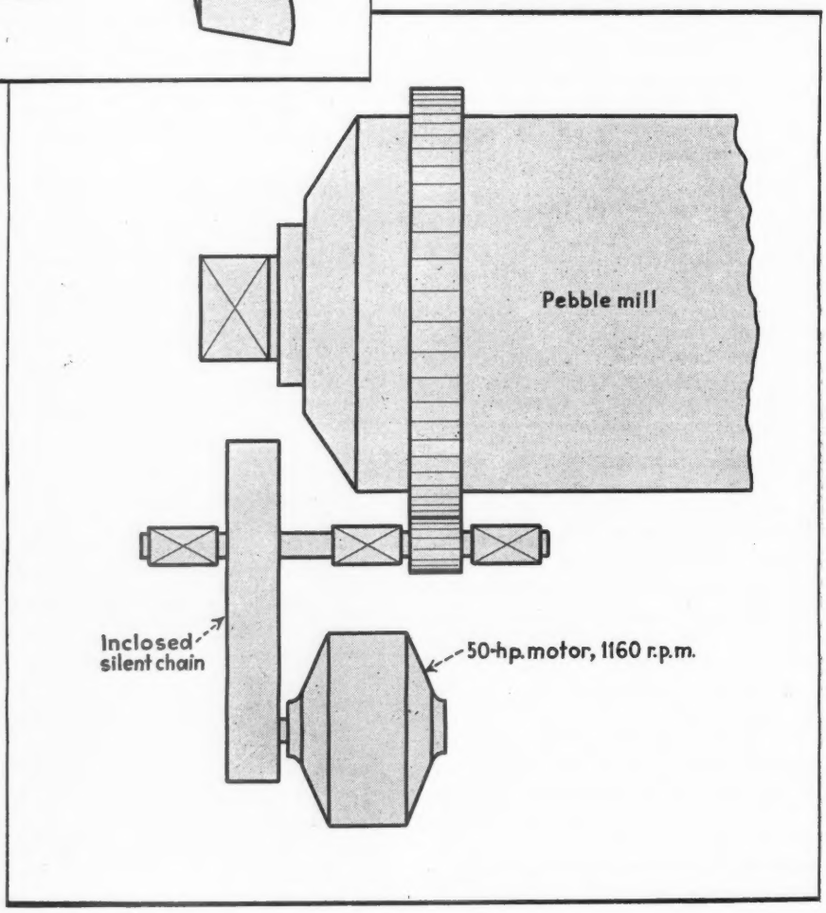


Figure 3. Action of the charge in alternately accelerating and retarding the motion of this pebble mill gave rise to shocks that resulted in breakage of the driving chain. The trouble was cleared up by installing a torque-limiting coupling on the motor shaft

150 r.p.m. proved to be the cause of the trouble, since 1,600 r.p.m. was just within the critical speed limits of the fan shaft. Operating this shaft at 1,750 r.p.m. took it beyond its critical speed limit; therefore, vibrations were set up which caused incessant pounding on the bearings. It was immediately evident that an increase in shaft diameter and larger bearings were imperative.

The shaft was increased to 4 15/16 in. diameter and new ball-bearing pillow blocks were installed. The impeller portion of the shaft was kept at 3 3/16-in. diameter. No further difficulties have been experienced with it.

There is a general tendency on the part of plant mechanical departments to hold mechanical power transmission equipment responsible for any and all adverse occurrences that interfere with smooth and economical plant operation. The incident described below demonstrates the fallacy of this notion; also, it indicates that prior to arriving at definite conclusions a thorough investigation of the entire installation should be made.

An exhaust fan having a 10-ft. rotor and a stationary vane frame, operating at 380 r.p.m., is driven by a 300-hp., 860 r.p.m., three-bearing motor through a totally inclosed, oil-sprayed, 18-in. wide by 1¼-in. pitch silent chain. See Figure 2. The fan shaft is 8 in. in diameter and is supported by two babbitted, ring-oiling bearings. Power is applied between the bearings by the silent chain drive, the fan rotor being overhung.

Blamed The Wrong Thing

A few weeks after the fan was placed in service, an excessive accumulation of oil appeared on the foundation immediately beneath the steel, oil-retaining casing of the chain drive and the inboard bearing of the motor. In addition, there was severe vibration and pounding of the fan shaft bearings, which in a few days necessitated dismantling the inboard bearing because of a cracked and scored babbitt shell.

Without consideration or investigation of the possibility of something being wrong with either the motor or the fan, the responsibility for both the oil accumulation and the bearing trouble was placed on the silent chain drive. It was decided that the oil was leaking through the regulation hat seal where the motor shaft entered the casing and that the vibrations were induced by either slackness and wear of the chain or an accumulation of minute vibrations set up as the links meshed with the sprockets. Accordingly, the chain drive was dismantled and thoroughly checked for alignment, wear, and slackness. In addition, new oil-sealing hats were placed around the motor shaft.

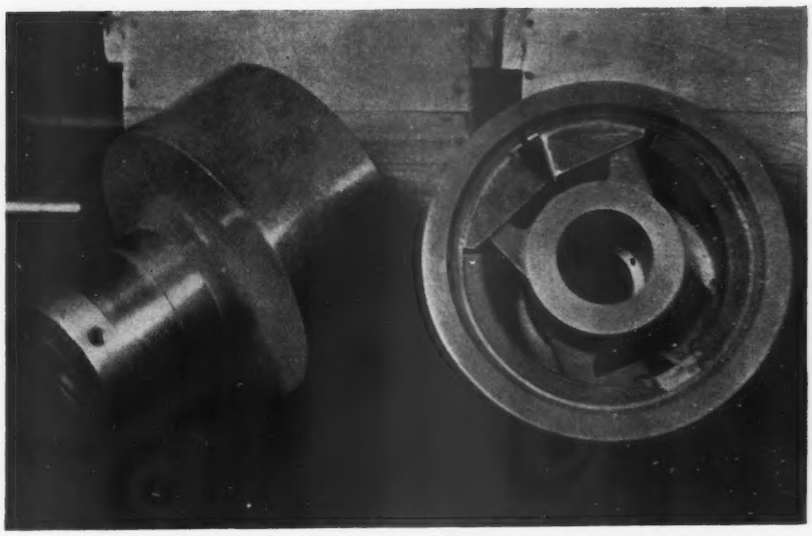


Figure 4. Type of torque-limiting coupling used on motor shaft to relieve stresses in the chain drive which Figure 3 illustrates

The fan shaft bearing was repaired and the chain drive reassembled. When put in service again excessive vibration of the shaft and leakage of oil were just as bad as ever. It was then evident that the cause of the trouble was not originating in the chain drive. Therefore, the fan was shut down and a thorough examination of the entire installation was made.

It was found that the major portion of the oil leakage came from the inboard bearing of the motor, because the two halves of the bearing housing had not been sealed properly, and that vibration and pounding of the fan shaft was due to a badly bent and twisted rotor blade. It had been damaged when a vane of the stationary vane frame broke loose and fell to the bottom of the fan casing while the rotor was turning at 380 r.p.m. This resulted in throwing out of balance a heavy mass rotating at comparatively high speed; consequently severe vibratory reactions were set up in the shaft and bearings.

Damage to the fan, and the motor bearing oil leakage, were repaired. The fan has now operated 24 hr. a day for the past eight months without any further evidence of trouble.

Grinding action of either a ball or pebble mill is accomplished by the material passing between the steel balls or stone pebbles as they are forced into a cascading action by the rotary motion of the cylinder. In a mill operating on dry or slightly viscous materials the cascading or falling over of the charge occurs slightly above the center of the mill, the exact location depending on the speed.

If the material being ground has a tendency towards stickiness as the grinding operation proceeds there is a possibility of the balls and charge clinging to the internal surface of the mill shell. When such a combination reaches the top of the mill, it will fall clear in a slanting, downward direction. Such action is detrimental to the driving equipment because the tendency is to push the mill ahead faster than it is being driven, which generates shocks and jerks that must be absorbed by the drive.

Overcame The Difficulty

An example of such difficulty was encountered with the drive for a pebble mill. This mill, which is 7 ft. in diameter by 14 ft. long, is driven by a 50-hp., 1,160 r.p.m. motor through an inclosed silent chain and thence by a pinion and ring gear, as shown in Figure 3. Process requirements made it necessary for the mill to remain stationary at intervals, which caused the materials being ground to become sticky. During the initial operation of the mill trouble was had with the silent chain drive in the form of pitch elongation, riding of the sprockets, and eventually chain breakage. Investigation proved the chain to be strong enough, but that it frequently received severe shocks from the mill. The pebbles and charge combined and revolved with the mill to the high point, and then toppled over as a dead weight against the opposite inside surface of the mill shell, thus forcing the mill to accelerate intermittently ahead of the drive.

The difficulty was overcome by the installation on the motor shaft of a torque-limiting, sprocket-type coupling, as shown in Figure 4. This device, because of its instantaneous releasing characteristics, permits a load to run ahead of the drive, thus protecting it from shocks or jerks.

When Lightning Strikes

Whether damage will be done to rotating machines and transformers depends upon how skillfully the protective devices have been fitted to conditions

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LIGHTNING protection embraces practically every portion of the electric power system, from the generator to the watt-hour meter or current-consuming devices. Protection of rotating machines, power transformers, cables, transmission lines, and so on, involves consideration of the basic characteristics of lightning, discussed in the March issue, as well as the characteristics and utilization of each item. Adequate protection of transmission line insulation may be inadequate for transformers and switchgear, and adequate protection for the latter is inadequate for rotating machines.

There are many theoretical angles involved, but it will be possible to discuss here only the practical aspects of protecting specific apparatus commonly found in industrial power systems.

A. C. Rotating Machines

Generators, large motors, and synchronous condensers or converters require a special class of protection to limit the surge amplitude to a safe value for the major insulation from line to ground and to slope off the wave front, thus avoiding excessive turn-to-turn stresses and preventing voltage increase by reflection within the winding. The protective equipment includes special capacitors, station-type arresters, and standard line-type distribution arresters, typical units being shown in Figure 1. The values of capacitance established are on the side of conservatism for the intended duty, and standardized designs of the special protective capacitors simplify application.

Modern protective capacitor units have an internal discharge resistor to drain off any residual charge when the unit is disconnected from the circuit. The special, station-type arresters have exceptionally low impulse breakdown voltage which is vital to this class of protection.

For machines directly connected to exposed overhead lines the protective scheme involves a special capacitor on the machine bus or at the terminals, supplemented by standard distribution arresters installed at points approximately 500 ft. and 2,000 ft. out from the machine on each directly connected exposed line.

With ungrounded-neutral machines, or machines with the neutral grounded through resistance or reactance greater than the machine surge impedance, the protective capacitor should possess at least 0.5 μf from each phase to ground, and the scheme of protection shown in Figure 2 will apply.

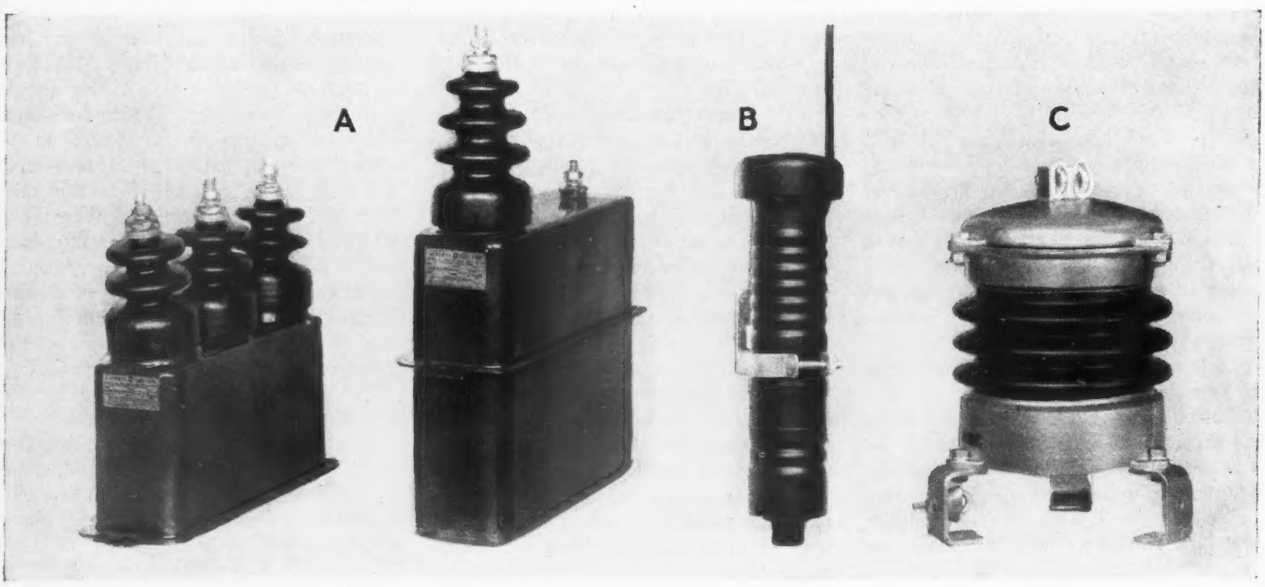
With Grounded Neutral

If the machine has a directly grounded neutral the same 0.5 μf protective capacitor is usually recommended (see Figure 3), but since no positive neutral reflections can occur it would be permissible to use a 0.1 μf capacitor if the line is paralleled by a special station-type Thyrite arrester.

This combination is, however, more economical only with the higher voltage machines, say 13,800 volts.

Where surges reach the machine through a regulator or reactor the special station-type arrester must always be used in parallel with the protective

Figure 1. Lightning protective equipment includes, *A*, special protective capacitators; *B*, line-type pellet arresters; *C*, station-type arresters



capacitor to prevent possible resonant voltage rises between the series inductance, L, of the regulator or reactor and the capacitance, C, of the protective capacitor. The latter may be 0.1 μf for rotating machines having directly grounded neutral, but must be 0.5 μf minimum for machines with ungrounded neutral. Figure 4 applies to this case.

Aside from the protection of the rotating machine, it is desirable to install a standard distribution arrester from line to ground directly at the line terminal of the regulator to protect it against incoming surges and reflections. This arrester is shown in Figure 4 in dotted lines.

Use Overhead Ground Wires

Where there are relatively short underground cables between the machines and the exposed overhead lines the same general scheme applies, except that the line arresters are located at points 500 ft. and 2,000 ft. out from the cable-overhead line junction, as shown in Figure 5. An additional line arrester will usually be required at the line terminal of the cable to protect the cable itself.

If it is desired to obtain a high degree of protection against direct strokes, each of the protective schemes discussed above should be supplemented by overhead ground wires effectively installed to shield the station itself and each of the exposed overhead circuits for a distance of at least 2,000 ft. This direct-stroke protection is shown diagrammatically in Figure 6, for a typical case.

The overhead ground wire should be effectively grounded at each pole structure, connected in to the line arrester grounds, and also with the station ground. The overhead ground wire is also indicated in Figure 5 by dotted lines.

When machines are connected through transformers to exposed transmission lines, lightning impulses exceeding the insulation strength of the machines may be transmitted through the transformers by both electrostatic and electromagnetic coupling, even when the high-voltage side is adequately protected by arresters. The machine may be overstressed by wave amplitude, or turn-to-turn overvoltages caused by wave steepness, or both.

If the rotating machine has a directly grounded neutral the protective scheme used is shown in Figure 7. The protective capacitor should have not less than 0.1 μf and the special station-type arrester should always be used in parallel with it.

A similar arrangement is used for an ungrounded-neutral machine but a larger capacitor may be required for some transformer connections. See Figure 8.

Where machines are subjected to lightning surges from directly connected exposed lines and also through power transformers from transmission lines the scheme of protection becomes simply a combination of those already discussed and is shown in Figure 9. This diagram also shows overhead ground wires for supplementary direct-stroke protection of both the directly connected, exposed circuit and the transmission line.

Although the protective equipment has a high degree of reliability it is usually considered advisable to protect the system against possible failure of this equipment. While the protective equipment may be applied to the machine bus and hence protect two or more machines connected to the same bus, it may be preferable in some cases to locate this equipment at the terminals of each individual machine so that the protective equipment will have the benefit of differential short-circuit protection.

When desired, suitable short-circuit protection in the form of circuit breakers or fuses of the required interrupting capacity for the available short-circuit current can be used in series with the protective equipment when the latter is connected to the machine bus.

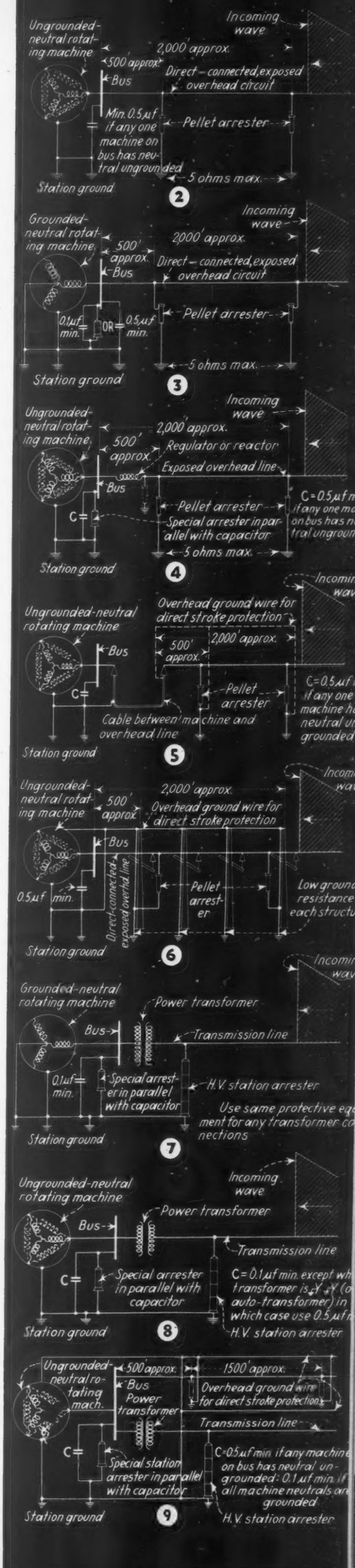
Applications of protective equipment are fundamentally the same for generators or motors of all voltage ratings and sizes. However, where motors are started under full voltage, without a starting compensator, connection of the protective capacitor on the motor side of the starting switch gives the motor the additional benefit of protection against switching surges which attend starting.

Synchronous Converters

These machines are frequently used to obtain direct current for industrial use. In some instances both the a.c. and d.c. sides of the rotary may be subjected to lightning surges.

Suitable protection of the a.c. side of the converter can usually be effected by standard lightning arresters on the high-voltage side of the converter transformer, assuming no exposure of the secondary circuit between the transformer and converter. Operating experience has not indicated the necessity for providing protection from the a.c. collector ring terminals of the machine to ground. This is due essentially to the short electrical length of the converter winding and its direct connection to the d.c. terminal of the machine.

Protection of the d.c. side of the con-



Figures 2 to 9. Methods of protecting grounded and ungrounded neutral rotating machines under different conditions

verter involves the use of a d.c. capacitor-type arrester, or the d.c. aluminum cell arrester, installed at the terminals of the machine. The d.c. capacitor-type arrester is the more modern development for protection of d.c. machines and railway systems, and eliminates the maintenance expense associated with the d.c. aluminum-cell type. It incorporates 4 μf capacitance from line to ground to provide substantially as good protection as the earlier aluminum-cell type of lightning arrester.

Whether the d.c. circuits from a converter are exposed to lightning or confined entirely within buildings it is desirable to apply the protection at the machine terminals. Even though lightning surges are not present this protection is desirable from the standpoint of switching surges attending the sudden changes common to many industrial loads, such as mine locomotives. Moreover, the d.c. capacitor-type arrester at the d.c. terminals of the converter tends to minimize commutator flashing attending short circuits or load changes.

Obviously, d.c. motors on the load end of exposed d.c. circuits should be protected by the d.c. capacitor arrester installed at the motor terminals.

Transformers and Allied Equipment

In substations the power transformers are usually the most important item of equipment, from the standpoints of investment represented, seriousness of service interruption, and repair costs in the event of failure. Adequate protection of substations lies essentially in obtaining a suitable margin of protection to the transformers. Where other apparatus, buses, switches, and so on, have insulation suitably above the modern coordination basic levels an adequate margin of protection to the transformer will usually assure satisfactory protection of the substation insulation in general.

Impulse protective characteristics of modern station-type arresters can be plotted directly against the volt-time impulse strength of transformers and hence denote the margin of protection for either short-time or long-time lightning waves. Since the protective level of any arrester depends to some degree on the voltage amplitude of the applied lightning wave, consideration of the transmission line insulation readily establishes this factor because lightning waves reaching the station cannot be of higher amplitude than the lightning flashover level of the exposed line on which the waves originate and travel.

Figure 10 shows a typical case involving a 34.5-kv. system. The line-to-ground flashover level of the line insulation involves a 45-kv. pin-type insulator plus 4.5 ft. of wood crossarm and pole insulation to pole guy wires. The top curve shows the impulse flashover voltage of this line insulation. The middle curve shows the permissible kilovolt stress on a modern 34.5-kv. power transformer which is insulated for the standard A.I.E.E. test of 225 kv. on 1.5x40 test wave. Lower curves show both the impulse breakdown voltage to start discharge and the *IR* drop during discharge for the station-type Thyrite arrester (for 34.5 kv. ungrounded neutral), and represent the highest lightning voltage which the arrester will allow from line to ground.

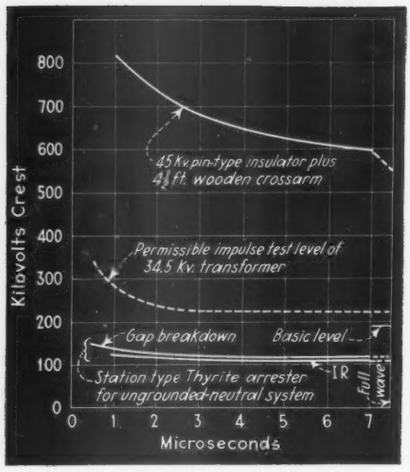


Figure 10. Volt-time protection and coordination data for a 34.5-kv. ungrounded system. It is assumed that the lightning arrester is located at the end of a line having 500 ohms surge impedance

For Small Substation

If the system neutral is directly grounded, permitting the use of a grounded-neutral design of arrester, the lightning voltage allowed by the arrester would be about 80 per cent of that shown on the curve for the ungrounded-neutral design. It will be seen in either case that the modern arrester has a relatively flat characteristic, assuring a large margin of protection below the short- or long-time impulse strength of the modern transformer. Moreover, the protection level for the arrester of 120-kv. rating, corresponding to the 1.5x40 full wave, is well below the established basic insulation level of 190 kv. for the same impulse wave.

For smaller and less important substations distribution-type (sometimes called line-type) arresters may be used instead of the larger and more expensive station type. Distribution-type arresters are available for circuits up to 69-kv. rating. Substitution of a 34.5-kv. distribution-type arrester in Figure 10 would result in a somewhat smaller margin of protection.

With the A.I.E.E. standard impulse test for arresters the 34.5-kv., distribution-type arrester breakdown voltage is about 10 per cent higher, and the *IR* drop about 20 per cent higher than for the station-type arrester. The cross-sectional area of discharge path and resulting heat-storage capacity of the distribution type is about one-fourth that of the station type. Although the over-all performance and reliability of the distribution-type arrester is not equal to that of the station type, the small physical size and lower cost of the former make it commensurate with the relatively small and less important substations.

In addition to line-to-ground protection some apparatus having series windings may require so-called bypass protection —an arrester to shunt the series winding and bypass the lightning surge to the main line-to-ground protection. Current transformers, the series winding of induction voltage regulators, or the series portion of regulating transformer windings can be protected against high turn-to-turn stresses by bypass arresters designed for this purpose.

Locate Arrester Properly

Substations supplying industrial plants often have several relatively short but exposed feeders or secondary circuits extending to different buildings. Too often these circuits are considered as not requiring protection, because of their limited length. Where the secondary side of the substation is connected to exposed lines, arresters should be used to protect the secondary side of the power transformers, buses, and other equipment. Failure of a transformer from lightning entering on the low-voltage side may be just as serious as failure from lightning on the high-voltage side. In addition, arresters should be installed where the exposed circuits enter or leave other buildings.

Location of the arrester in the substation is important in attaining the most effective protection. Because of the steep wave front and resulting voltage gradient over a relatively short length of conductor, the arrester should be placed in relatively close shunt relation to the insulation to be protected. Since power transformers are usually regarded as the most important item of equipment in the substation, there is some trend to locate the arresters close to, or directly on, the transformer.

(Methods of protecting cables and other equipment will be taken up in a succeeding article, which will be the third and concluding installment of this series.—Ed.)

When Controls Won't Work

Then is the time when knowledge of causes, symptoms, and probable location of trouble is worth any amount of haphazard groping in the dark and playing hunches

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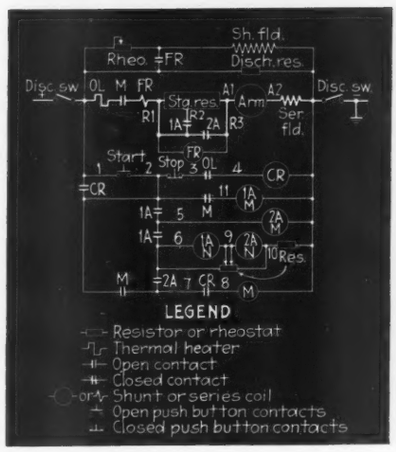
A PRECEDING ARTICLE, in March, covered some of the conditions that cause faulty operation or failure of control equipment. Knowledge of the principal causes of trouble will make it possible to take appropriate preventive measures against them. It is hardly to be expected, however, that no trouble will ever occur. Therefore, knowledge of how to locate and correct faults that may develop in the operation of control apparatus is equally important.

When various control units are used in groups to make complete controllers they must be interconnected with each other. They must also be wired to auxiliary equipment such as pushbuttons, master switches, limit switches, signal lights, and other essential devices. The introduction of wires with many connections involved, and complicated conduit systems to carry these wires, obviously introduces possibilities of circuit trouble.

To illustrate the points that will be brought out, let us take a d.c. nonreversing, magnetic starter for a compound-wound motor. The circuits are shown in the diagram.

Generally speaking, the statements referring to this circuit will apply equally well to a.c. circuits. It illustrates, however, field circuits that are not common on a.c. motors except the synchronous types. The overload protection, push-button circuits, starting resistors, and low-voltage protection features are in such general use on both d.c. and a.c. circuits that control troubles of one type of circuit are common to the other.

With this d.c. control three points of definite time acceleration are provided by the definite-time accelerating units marked *1A* and *2A*. These units are spring-closed and magnetically opened. Each has two coils on the core of the magnetic circuit. The main coils marked *1A* and *2A* open contacts *1A* and *2A* when energized. After the main coils have been opened, timing coils *1AN* and *2AN* oppose the residual magnetism and permit the springs to close the contacts. The time depends upon the strength of these coils, and can be regulated by the adjustable resistor in parallel with them.



Circuit diagram of a non-reversing, magnetic starter for a compound-wound, d.c. motor

Accelerating contactors *1A* and *2A* are provided with auxiliary or control contacts in the control circuits that must be closed before coil *M* can be energized to start the motor. This will require that main contacts *1A* and *2A* be open—hence all armature resistance will be effective—before line contactor *M* can be closed to start the motor.

Symptoms and Causes

The field rheostat provides speed control by adjusting the strength of the shunt field. The series coil on the field relay, *FR*, permits starting the motor with the field rheostat set for maximum speed, by periodically closing its contacts to short circuit the entire field rheostat in case the armature current of the motor rises to objectionably high values. The shunt coil connected to *R1* and *R3* of the starting resistor definitely closes *FR* to provide full field strength, hence maximum torque, for starting conditions.

The field discharge resistor prevents insulation breakdown on field and control coils by limiting the induced voltage of the shunt field to safe values when the disconnecting switch is opened.

With a circuit such as illustrated here, certain conditions may occur that produce unsatisfactory operation of the motor and control. Some of the most common troubles and their causes are as follows:

1. Motor will not start.

If the contactors and relays appear to operate properly the trouble is probably due to an open in the main circuits to the motor armature.

(a) The disconnect switch may be open.

(b) The overload heater may be burned out.

(c) Series coil of the field relay, *FR*, may be open-circuited.

(d) Starting resistor may be open-circuited.

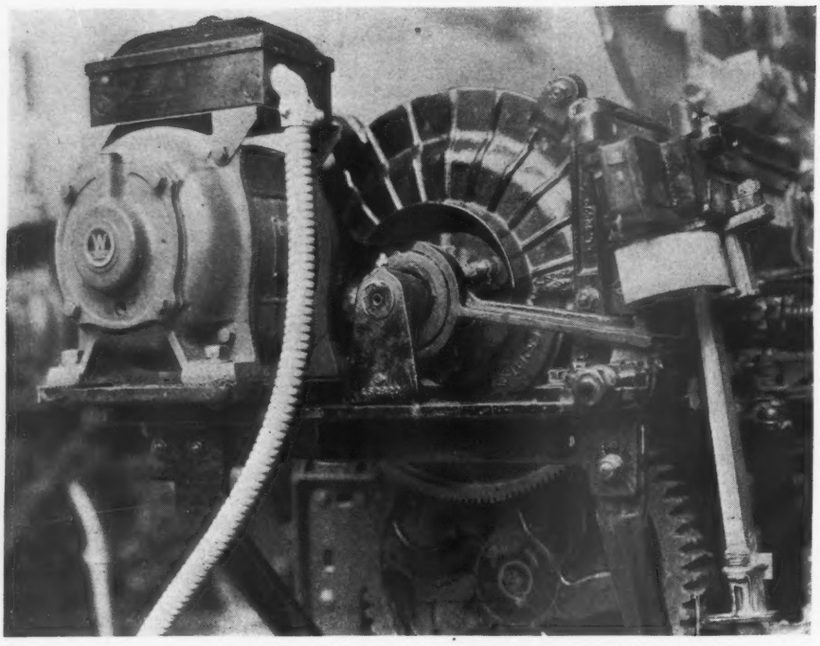
(e) Contact tips of main contactor *M* may not be completing the circuit properly.

(f) Armature and series field circuits of motor may be open.

(g) There may be loose connections or broken conductors in the armature circuit.

Some of these conditions can readily be determined by visual inspection. It may be somewhat difficult to tell by sight alone whether the starting resistor is defective. However, if the circuit is open at main contacts *M* and a test light—a flashlight with external connections is very convenient for this purpose—is connected to points *R1* and *R3* one can promptly determine whether the starting resistor is open-circuited. A light will be obtained if the resistor is not damaged. If damaged the test light will not glow.

2. Control circuits will not function to start the motor.



Severe vibration makes life harder for this motor-mounted starter

(a) The start button may be blocked or the contacts bent so that when pressed down no contact is made.

(b) Stop button contacts may be blocked open.

(c) If overload relay is of hand-reset type its contacts may be latched open.

(d) If overload relay contacts are closed there may be enough dirt or foreign material on the contacts to cause an open circuit.

(e) If relay coil *CR* closes but does not remain closed when the start button is released, the circuit from point *1* through the contacts of *CR* to point *2* on the start-and-stop button is not complete.

(f) It is necessary for accelerating contactors *1A* and *2A* to operate in sequence to open their main contacts and close their auxiliary circuits *2* to *5* to *6* to *7* because these auxiliary circuits and relay *CR* must close to energize coil *M* of the main motor contactor.

(g) Coils *1A* and *2A* and *M* must not be defective.

3. Motor starts but will stop when start button is released.

(a) This condition is due to an incomplete holding circuit for relay *CR*, as outlined in *(f)*, or an incomplete holding circuit 2 to 7 for main contactor coil *M* through the auxiliary contact of this coil.

4. Motor starts but will not accelerate.

(a) Main contacts *1A* and *2A* may not be making contact.

(b) Auxiliary contact *M* from point *2* to *11* may not be opening coil *1A* when main contactor *M* closes. If so, the spring on *1A* can never close its main contacts to short-circuit starting resistance step *R1* to *R2*.

(c) If *1A* does not operate to accelerate the motor *2A* cannot operate because the auxiliary contacts of *1A* must open coil *2A* in sequence.

(d) Neutralizing or timing coils *1AN* and *2AN* may be defective or not strong enough to neutralize the residual magnetism of *1A* and *2A* after the main coils are de-energized.

5. Motor starts and accelerates but no speed adjustment is possible.

(a) The rheostat may be partially or entirely short-circuited, just as though a jumper were placed across its terminals. Under this condition maximum field strength will be applied to the motor regardless of the position of the rheostat handle.

(b) Relay *FR* may remain closed and short circuit the entire field rheostat.

6. Motor alternately runs fast and slow.

(a) This is due to erratic operation of relay *FR*. Overload conditions may be causing its series coil to close the contacts of *FR*.

(b) Temporary short circuits may occur in the field rheostat.

7. Motor runs at excessive speed.

(a) Rheostat may have too much resistance so that the field strength is reduced to an excessively low value.

(b) Shunt field circuit may be open and motor tends to operate at runaway speeds.

8. Motor accelerates too fast.

(a) Neutralizing or timing coils *1AN* and *2AN* are too strong and are reducing residual magnetism to zero too rapidly. Change adjustment on timing resistor in parallel with neutralizing coils.

9. Starting resistor overheats.

(a) Starting time or starting conditions are too severe for design of resistor. Load may be too heavy. Starting time may be too long. Starting may occur too often.

(b) Accelerating units *1A* and *2A* may not be operating and starting resistor may be in circuit continuously.

10. Motor stops unexpectedly.

(a) Overload may have operated overload relay.

(b) Momentary low voltage may have caused magnetic contactors to open.

(c) Vibration may have opened stop button contacts.

(d) Holding circuits *1* to *2* and *7* to *8* on relay *CR* and *2* to *7* on auxiliary contact *M* may have failed and de-energized coil *M*.

11. Motor does not stop when overload contacts open or when stop button is operated.

(a) Contacts of overload relay or stop button may be short-circuited by incorrect wiring. Stranded wire used to make pushbutton connections may cause trouble of this nature if a loose strand from point *3* should touch wire *2* or *vice versa*.

(b) Relay contacts *CR*, auxiliary contact *M* (marked *2* to *7*) or main contacts of *M* may be blocked or welded together.

12. Motor starts when disconnect switch is closed and before start button is operated.

(a) This is due to a short circuit in parallel with the start button from point *1* to *2*.

Grounded connections can be the cause of very troublesome operation. They may be serious at times and are often difficult to locate. Complete replacement of conduit wiring is often the only solution to frequent or persistent grounds in conduit systems.

If the grounded connection is not a very positive contact or if the resistance in the grounded circuit is high there may be no serious results. It is, therefore, the nature of the ground and the resultant circuit that are really most important.

Some systems, such as railway circuits, are of necessity grounded on one

(*Continued on page 102*)

Watts on Wheels

New wrinkles in distributing energy remove the leash that fixed outlets impose on lights and small power tools, increasing their working area

G. A. VAN BRUNT
Associate Editor

CANDLES and oil lamps are pretty poor light sources, as compared with today's electric bulbs and tubes, but they have the great advantage of mobility. You can carry them around and put them down or hang them up wherever they will do the most good.

When electric lighting came in, mobility went out. To be sure, lighting units can be located almost anywhere but when once installed they remain fixed. With conventional methods of installation, changing the location of lighting fixtures usually involves considerable labor and expense.

Means of obtaining mobility of lighting fixtures and small power equipment have recently been developed by Bull Dog Electric Products Company. Basically, the new system of wiring comprises insulated copper busbars inclosed in and protected by a sheet-steel duct. Sections of duct are joined by the use of couplings, elbows, and other fittings to form a continuous, flexible distribution system. Lights, portable electric power tools, and any appliances or equipment of moderate capacity can be plugged into this system at any desired point, or be arranged to receive power from movable, current-collecting trolleys. If desired, provision can be made for fusing and switching at the tap-off points.

The system is designed primarily for single-phase service, but can easily be arranged to provide two or three-phase by the use of two parallel ducts.

Duct casing has a narrow, continuous slot in one wall through which the inclosed busbars can be reached. Cross-sectional dimensions of the casing are approximately $\frac{7}{8} \times 1\frac{7}{16}$ in. Capacity of the busbars is 50 amp. They are insulated except on the contact surfaces.

Standard duct can be had in ten lengths, ranging from 1 to 10 feet.

Trolleys for Mobility

Six types of couplings have been developed for joining sections of duct under different service conditions. They are all provided with busbar clips and slipped over the ends of the sections.

Ducts are suspended by a simple, clip-type hanger into which they are slipped and then snapped into place. These hangers are provided with a countersunk hole in the center and a slotted ear on each side, for greater convenience and flexibility in mounting. When the center hole is used for mounting the ears may be broken off to improve the appearance.

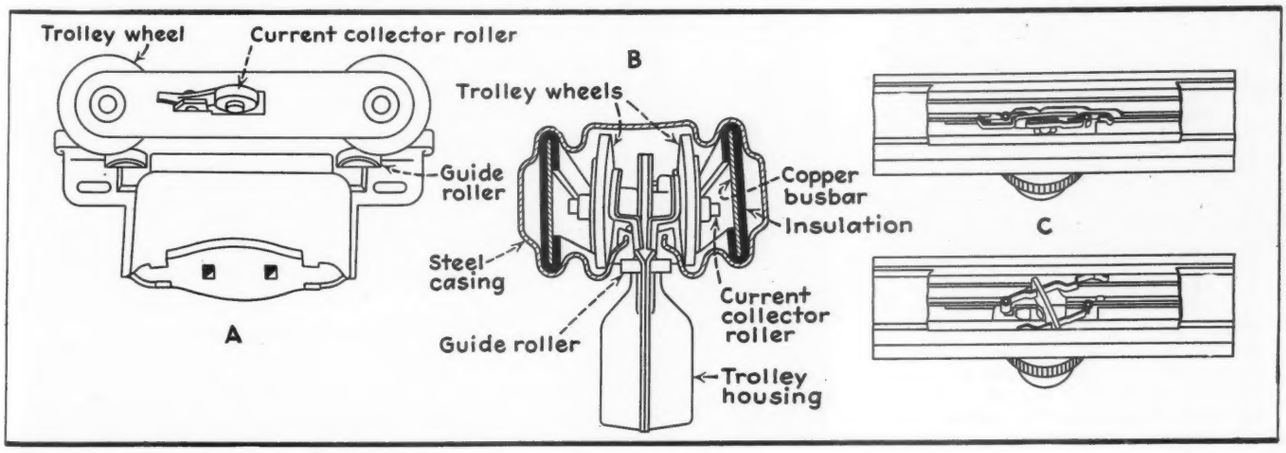
When it is desired that lights and tools be shifted frequently along a duct line without breaking the circuit, use is made of a trolley, of which two types are available. Both types of trolleys have essentially the same construction and consist of a small, four-wheel carriage which rides in the duct. Contact rollers on an arm on each side of the trolley are forced by spring pressure against the copper busbars and collect current from them. Thrust rollers under the wheels keep the trolley in proper alignment in the duct. A Bakelite barrier running the length of the trolley on both sides prevents the contact arms from striking the duct while the trolley is being inserted.

The so-called terminal-type trolley is used where the wires from the devices to be operated are connected directly to the terminals inside the trolley. Receptacle-type trolleys are provided with a contact receptable for plugs.

Both types of trolleys can be inserted or removed from the duct through a special trolley entrance coupling, an end cap, or a union coupling.

Where it is not required that lights or appliances have the mobility that is provided by the use of a trolley, a special type of plug may be employed. These plugs are also made in the terminal and receptacle types. A plug can be located at any desired point in the duct by inserting it through the slot and giving it a 90-deg. turn. Through the medium of a cam action this turn

Receptacle-type trolley, *A*, into which lights or appliances can be plugged. Shape of the duct and location of the busbars, with a trolley in place, are shown in *B*. Contact arms of a plug are collapsed when it is inserted in the duct. Lower view at *C* shows how arms are expanded and locked in place



Trolley suspension permits lamps to be grouped when high intensity is required in one spot, or spaced for lighting a larger area

The sub-assembly table in the center can be moved over a considerable area without interrupting the power supply, obtained from the overhead duct. Lighting fixtures on both sides are also wired to trolleys and can be spaced as illumination requirements dictate

causes the two contact arms to be forced against the busbars in the duct and locked in place. To remove, the plug is twisted in the opposite direction and pulled out of the duct.

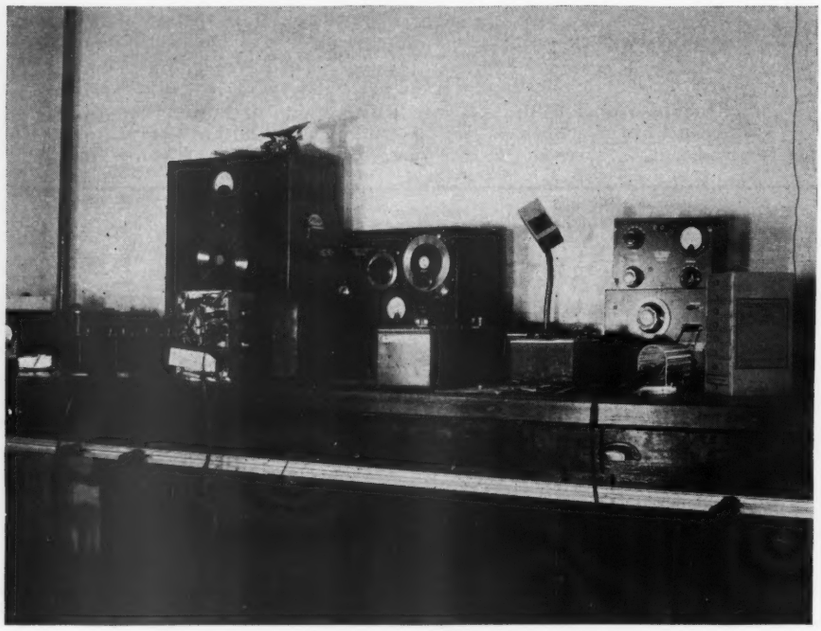
General applications of this flexible distribution system will be obvious. Some arise from the fact that frequent and radical changes in the location of production machines and workbenches are the rule rather than the exception in many plants. Under these conditions a lighting system that may have been quite adequate for one layout may fall considerably short of meeting the requirements imposed by the new arrangement. Relocating fixtures to meet the new conditions is expensive; so also is the expedient of providing a sufficiently high level of general illumination to meet specific local needs.

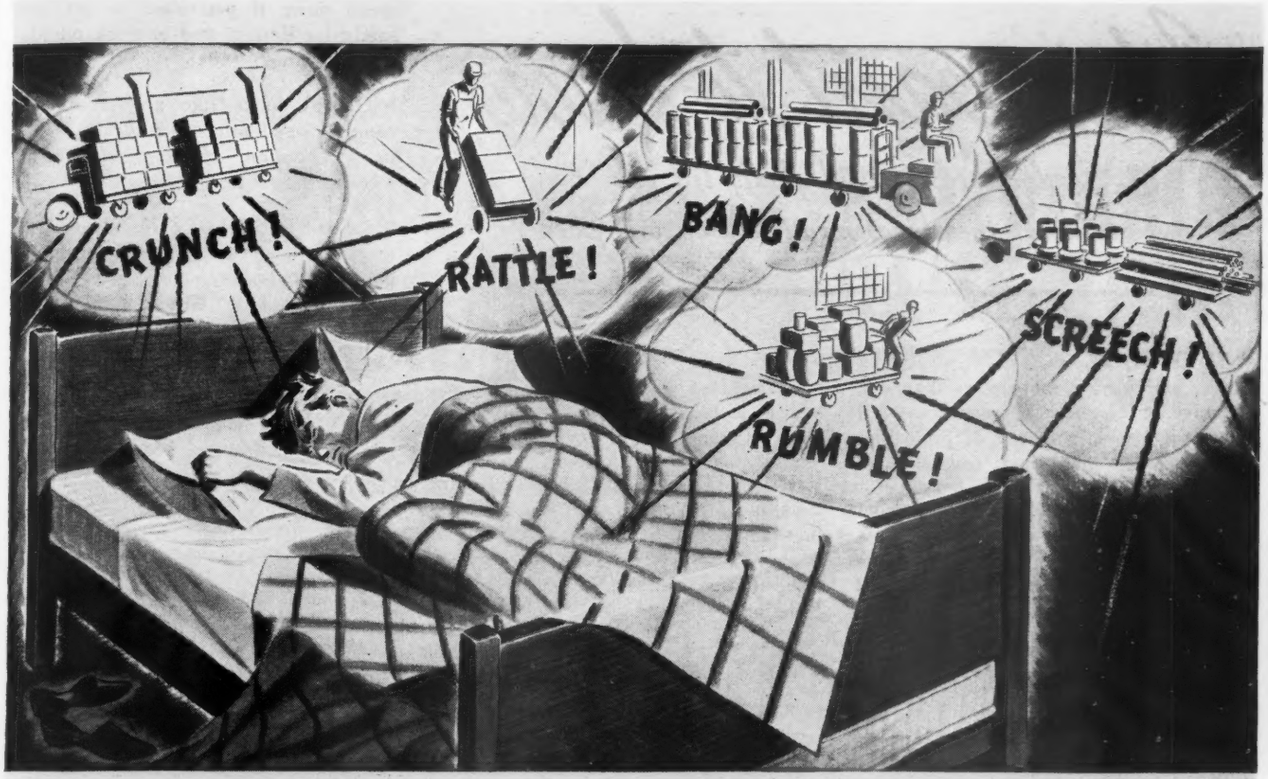
With the new system, lighting fixtures can in a few minutes be relocated as necessary along any duct line. Or, when needed, an existing duct line can be quickly moved, or a new one installed.

Much the same situation exists with respect to the use of portable power tools in production, assembly, or maintenance work. In addition to frequent changes in location, it is often necessary to move them back and forth over a considerable distance. Here again, fixed power outlets leave something to be desired in the way of convenience.

In the inspection and adjustment of some kinds of electrical equipment it is necessary or desirable that the units be kept under power while they are moving along the test benches or on a conveyor. Under these circumstances use of a trolley duct lowered production costs considerably for a Michigan radio set manufacturer—to cite an example. Formerly sets were plugged in and out all the way down the testing line. With this procedure the sets were, of course, alternately hot and cold, so that the inspectors had to sit idle until the sets warmed up sufficiently to permit the different tests to be made. Sets are now plugged into trolleys at the starting point and are kept hot until they reach the end of the testing line.

Duct section on radio test table permits power to be taken off where needed





HE HEARS STEEL WHEELS IN HIS SLEEP

NOISE IS WASTEFUL . . . COSTLY . . . Clang! Thump! Bang! All day long this worker hears steel wheels clattering by, screeching and grinding. No wonder work is a torment, sleep troubled.

You can stop the nerve-wracking noise of steel wheels. You can conserve human energy. You can increase production. You can end high floor repair costs. Just put inexpensive Goodrich Vulc-On Rubber-Tired Wheels on your material-hauling equipment. Rubber is quiet!

Power Costs Drop

The cost is surprisingly low, but you'll save money right from the start. Rubber tires don't grind and splinter floors. Trucks roll easier, faster. Power costs drop. Equipment lasts longer. Loads are cushioned — breakage reduced. And once you are rid of the everlasting noise and vibration men do more work per day.

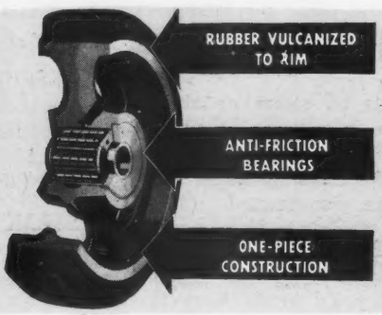
Modern Vulc-On Wheels have no nuts or bolts to loosen and get lost. Completely enclosed anti-friction roller bearings further reduce power needs. The wheels are rust- and corrosion-proof. Rubber tires are permanently vulcanized to the metal rim — can't stretch or come off.

Act Now

A Goodrich Transportation Engineer will survey your equipment, give you information on floor wear, power savings, proof of savings in your own plant. Phone the Goodrich Silvertown Store in your city or send in the coupon below.

Goodrich *Industrial* Tires

THIS GOODRICH VULC-ON WHEEL *Pays its own way!*



Dept. N-49

The B. F. Goodrich Co.
Akron, Ohio

Gentlemen: Please mail me (without obligation) your booklet on Goodrich Industrial Tires and information on how they pay for themselves.

Name _____

Company _____

Street _____

City and State _____

You want to know

and the editors will gladly tell you more about the things mentioned on this page

• YOUR INVENTORY — what's it worth? There are more ways than one to arrive at the answer; so one research group undertook a survey of prevailing practices, and published results in a pamphlet. (4801)

• CHART classifies eye-hazardous operations by industries, recommends specific types of eye-protection equipment developed for each hazard. (4802)

• PATCHING MATERIAL finds use in all sorts of places. It adheres to metal, wood, fabrics, rubber, and leather, and dries to a tough, elastic, waterproof, non-conducting surface. (4803)

• PHOTOELASTICITY is theme of a new publication which will be devoted to the stress-strain relation, polarized light, and plastics. (4804)

ACID BUCKET makes handling of corrosive materials safer. Made of a semi-flexible material, it's filled to its 3-gal. capacity when liquid is 2 in. from the top, a factor that lessens spillage. On the inside are graduation marks. (4826)

• BROWN TAPE, which gets its color from its raw rubber base, is claimed by its manufacturer to have exceptionally long life. (4805)

• MILL WHITE PAINT, mildew-proof, will find a job waiting it in plants operating under high temperature and humidity conditions. (4806)

• PROTECTOR for bin cards, shipping tags, stock tickets, and the like has a metal back and a Cellophane front. Can be had in any size. (4807)

• INDUSTRIAL RELATIONS has been moving so fast that executives in that and other fields will jump to get a copy of the revised bibliography, "The Office Library of an Industrial Relations Executive," just out. (4808)

• METAL COATING, applied to metal surfaces before welding, prevents metal spatter from adhering. After welding. it can be easily cleaned from the surface with hot water. (4809)

• FLOORING MATERIAL has multiple virtues: Sound-deadening, non-slippery, moisture-resistant, resilient under foot. Use it in damp basements or on flat roof recreational areas. (4810)

• WRAPPING PAPER is absorbent, and tough when wet. According to its maker, it can take quite a beating under moisture conditions. (4811)

• RELIEF is still an unsolved problem, says a pamphlet, with too much emphasis on particular types of need. The many types of social assistance must be integrated and harmonized. (4812)

• SEALER for paper, textiles, leather, and other fibrous surfaces forms transparent, colorless film which prevents absorption of paints, varnishes, and lacquers. Can be used to prevent penetration of oils and greases into paper, too. (4813)

• WE'VE HAD staplers for a long time. Now a staple remover. It does the job without tearing papers. (4814)

• CEMENT, acid-proof and oil-proof, is intended as a bond for acid-proof bricks used in construction of basins and troughs for acid liquids. (4815)

• VALVE shuts off steam or air the instant pressure in a steam or air line goes out of balance. A safety device, it commands the situation when hoses burst or become disconnected. (4816)

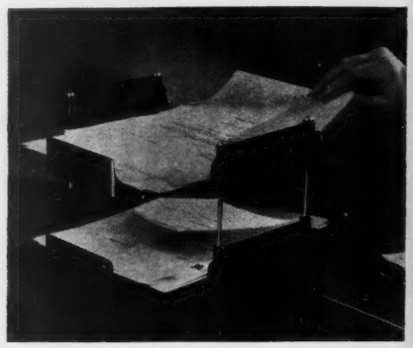
• "DEATH BEGINS AT 40"—on the highway. Pictorial booklet drives home the point that you'd better keep that speed down if you want to get home safely for dinner, and to work on Monday morning. (4817)

• OILER looks like a fountain pen, supplys one-tenth of a drop through its steel point when pressed against mechanism to be oiled. (4818)

• ASBESTOS GLOVE for handling hot materials has seams between the fingers, none on palm or back, so that it can be slipped onto either hand. Comes lined and unlined, and in different lengths. (4819)

• PICK-PROOF LOCK can't be opened with any instrument other than the owner's key. Dogma of the hardware trade has been that no key-operated lock could be invented that could not be picked, but the manufacturer claims to have turned the trick. (4820)

• ALUMINUM PAINT and primer form a protective coating over metal surfaces when applied. The primer contains three rust-inhibiting pigments. (4821)



LETTER TRAY, molded of plastic, has open corners so that letters are easy to get at. No time lost trying to grasp a corner that doesn't want to come. Another tier can be added at any time to make it a three decker, or the two tiers can be separated into two single trays. (4827)

• SPRAYABLE PLASTIC protects concrete, steel, and wood from corrosion. It bonds to the base material, can be pigmented to most any color. (4822)

• MOTION PICTURE shows harmful effects of silicosis by following a typical exposed workman through his disabilities, to his collapse. Then it shows steps that might have been taken to prevent this tragedy. (4823)

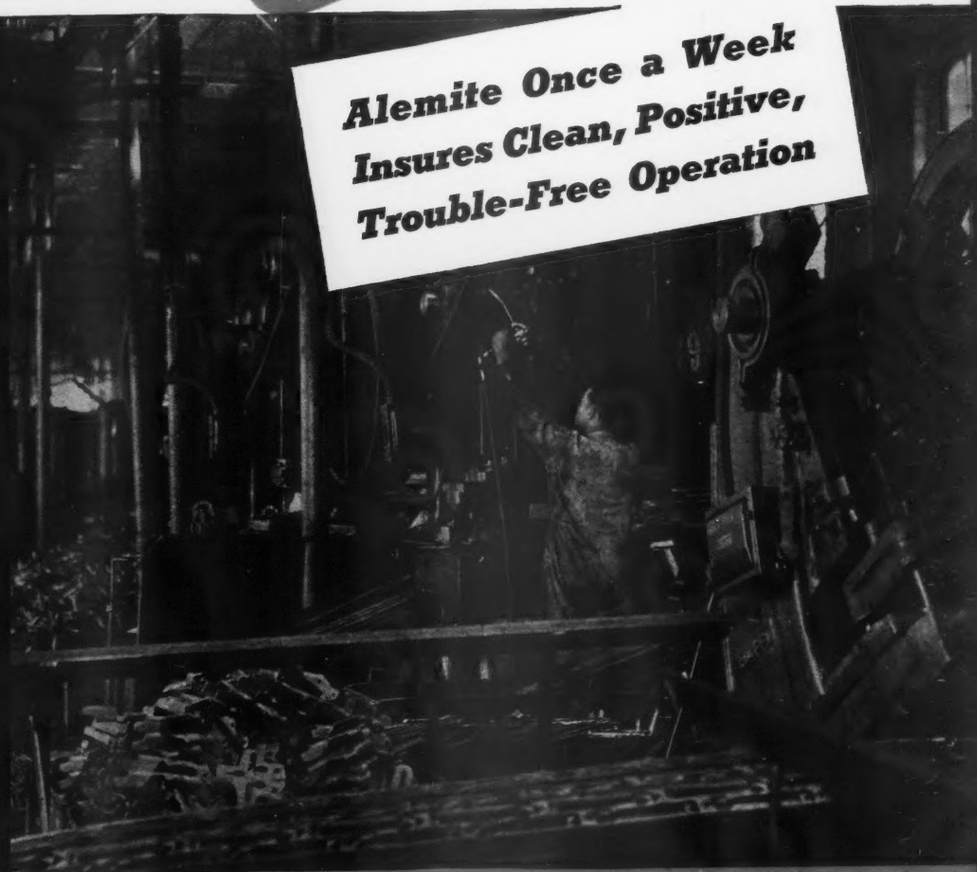
• RESPIRATOR for Type A dusts has more than 30 sq. in. of felt filtering surface looped into a small space. Clean it by blowing compressed air into the core. (4824)

• STAMP PAD INK penetrates most papers so quickly that there is little or no blurring of impressions if they are rubbed "when wet." (4825)

No More HOT BEARINGS! DAILY OILINGS!

ALEMITE ADJUSTABLE AUTOMATIC PRESSURE CUP

Designed for constant delivery of a predetermined amount of lubricant during a set period of time. Easy to fill; easy to adjust; adaptable for use with any type of Alemite Fittings. Position of Plunger indicates amount of lubricant in cup. Available in 3 sizes, from 1 to 4 oz. capacity. Can be fitted to any size bearing openings by use of bushings.



Alemite Once a Week Insures Clean, Positive, Trouble-Free Operation

THE back shaft bearings on these 75-ton presses used to run hot all the time, according to maintenance officials at S. L. Allen Co., Philadelphia, manufacturers of the famous Flexible Flyer sleds. It took *about a gallon of oil a day* to keep them from overheating.

But since they've been using Alemite No. 33 Lubricant, with Alemite Automatic cups and the Alemite Model 6190 Electric Power Gun, *once-a-week lubrication is ample!* Now they have clean, positive, trouble-free operation — with less time spent on lubrication and less money spent for lubricants.

There are 25 of these giant presses and nine power hammers in the Allen plant, *all Alemite-equipped and all lubricated by one Alemite Power Gun!* This gun holds 25 lbs. of lubricant, delivering 12 oz. per minute under pressure of 4,500 lbs. per square inch. Universal motor for A. C. or D. C. Mounted on 3 casters; easily portable.

Whether your machines are huge heavy- duty presses like these, or smaller, lighter units, there's an Alemite System, power or manually operated, *which can cut your production costs and speed your schedules.* Alemite's years of successful experience are at your command. Write to us about your specific problems, and we'll be glad to tell you how others have met similar requirements at a saving.

ALEMITE—*A Division of Stewart-Warner Corp'n.*
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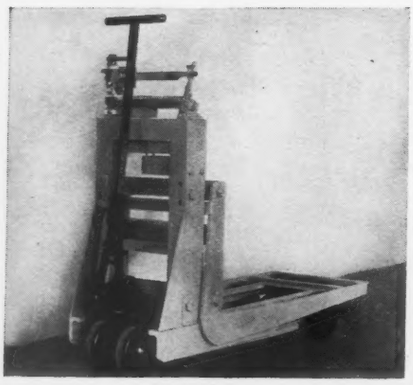
ALEMITE

REG. U. S. PAT. OFF.

WORLD'S LARGEST MANUFACTURER OF LUBRICATION PRODUCTS

Enjoy Horace Heidt and his Alemite Brigadiers every Tuesday Evening, over N B C Coast-to-Coast Network, 9:00 p. m., E. S. T.

What's New in Equipment

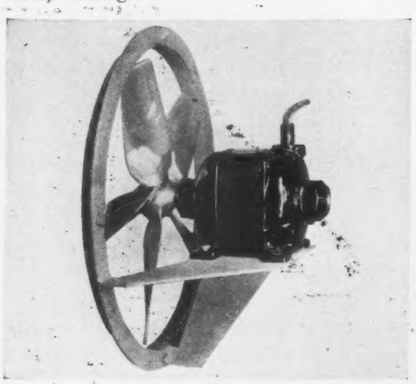


Scale Trucks

No. 562 comes in 3,500- and 5,000-lb. capacities, in single- and multiple-stroke types. It is combination of a beam scale and lift truck. Its size permits handling skids or platforms in sizes from 24x30 in. to 48x60 in. No. 560 is light-duty truck with a dial scale. A single-stroke type, it has capacity of 2,500 lb. Handles skids up to 36 in. wide and 30 to 36 in. long. Barrett-Cravens Co., 3255 West 30th St., Chicago.

Exhaust Fans

W F D exhaust fans remove vapors and odors. Furnished with a guard over a 5-bladed propeller. Can be placed in window, transom, or other opening by mounting a wood or metal frame around it. Explosion-proof motors. Sizes from 18 to 34 in. Binks Mfg. Co., 3114–40 Carroll Ave., Chicago.

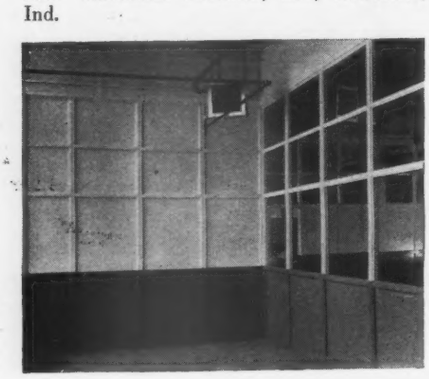


Water Coolers

Electric water coolers are designed in capacities from 4 to 23 gal. per hour, using motors from ¼ to ¾ hp. Cabinets constructed of 17-gage spot welded steel, finished in gray lacquer. Cabinets sizes are 18x18x40½ in. and 22 x 22 x 40½ in. There is an acid-resisting, cast iron, vitreous-enameled head which covers entire top of cooler. Automatic control is installed inside of cabinet and maintains constant stream height, regardless of pressure. All connections are through back of cabinet. There is a brass storage tank surrounded by 2-in. insulation. Thermostat is in direct contact with outlet water. Compressor assembly is set on rubber to reduce vibration. The Halsey W. Taylor Co., Warren, Ohio.

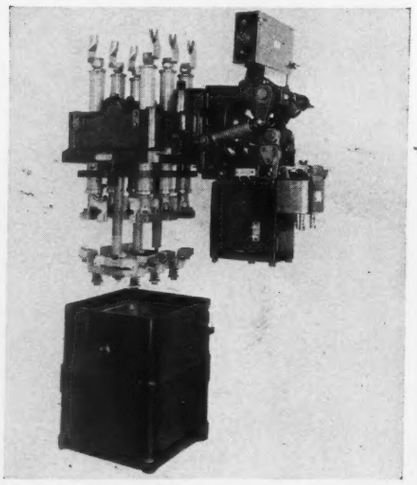
Partitions

Circle A factory partitions are heavy and substantial enough to withstand abuse. Made in standard sections 3 ft. 2 in. wide. Smaller sections are supplied to meet total length requirements. Set directly on the floor, the sections are bolted solidly together. Available in railing height (7 ft. 3 in.) or ceiling height (up to 16 ft.). Furnished with wood panel to wainscoting. Either glass or wood paneling is furnished above chair rail. Newcastle Products, Inc., Newcastle, Ind.



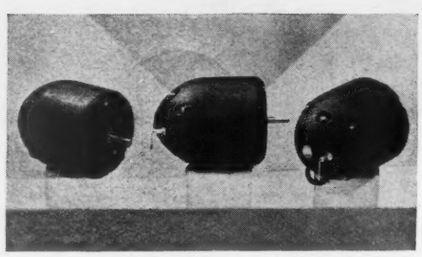
Circuit Breaker

Type DX-40 indoor oil circuit breaker is designed for heavy-duty starting of large synchronous and induction motors. Special feature is the use of expulsion ports which hasten arc extinction. Other features are: Large butt-type arcing contacts; main contacts of wedge and finger type with silver contact surfaces; cast steel top frame; reinforced, electrically welded steel tank. Furnished for 600 and 1,200 amp. at 15 kv. with an interrupting capacity rating of 100,000 kva. Allis-Chalmers Mfg. Co., Milwaukee.



Motor

Motor is shaped to blend with usual fan or air circulator design and to offer least possible resistance to air flow. Has barrel frame to facilitate mounting in ring or yoke. Built with split-phase windings for 1,150 or 1,725 r.p.m., with start and stop pull switch. Also available with windings for two speeds, 860 and 1,140 or 1,140 and 1,725 r.p.m., with a three-position pull switch. Also built to operate with a separate transformer capacitor control to run at two or three speeds. Built in sizes of ⅛, ⅓ or ½ hp. to operate fans from 20 to 32 in. in diameter. The Ohio Electric Mfg. Co., 5914 Maurice Ave., Cleveland.

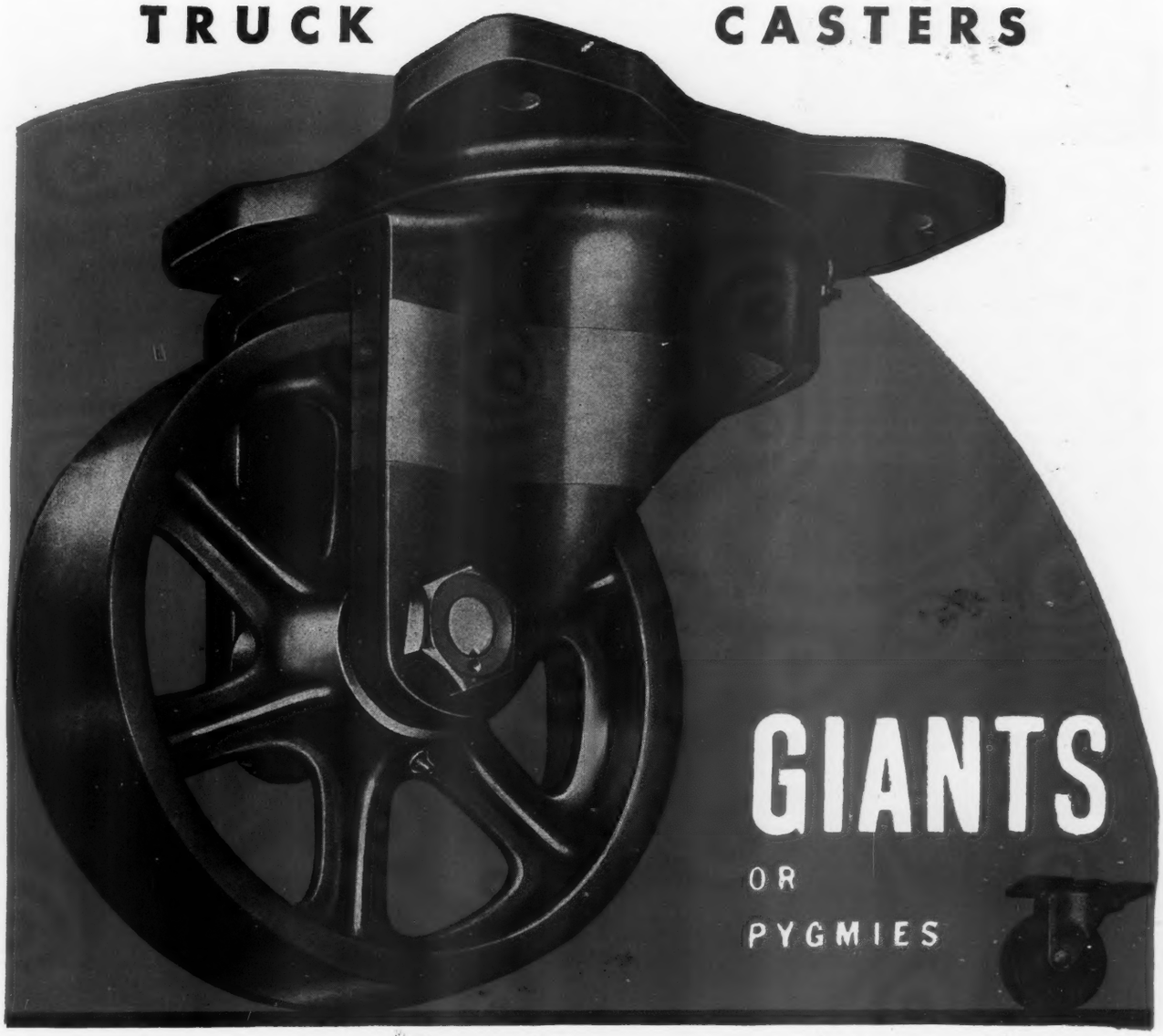


Communication System

Communication system requires no wires, using the electric circuit wiring as both source of power and communication channel. Operates on a.c. and has a dial selector to permit two-way communication with the remote station tuned in. Made in two models: one for two-way, and one for multiple communication. Multiple system consists of one master and as many as five remote stations. The master through the use of the selector switch may communi-

Bassick

TRUCK CASTERS



. . . *for every type of service*

WHATEVER your need—big heavy duty trailer casters or small casters for light portable equipment—there is a Bassick Caster for every service. Ranging from giants to pygmies, there are thirteen distinct types of Bassick Truck Casters available in the proper types and sizes. Supreme in quality, they are economical in both initial cost and durability.

If you have had trouble with truck casters you will appreciate Bassick Casters on three counts: *easier swiveling, greater strength* and *economy.* You will also appreciate the convenience of dealing with a company that has the facilities to furnish a correct type of caster for your special requirements.

The new Bassick developments in truck casters and the sure economies they afford are worth attention. A catalog will be mailed at your request.

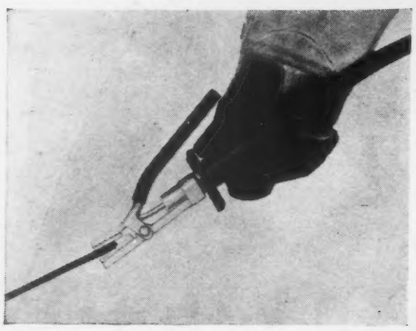
THE BASSICK COMPANY, Bridgeport, Connecticut

Canadian Factory: STEWART-WARNER—ALEMITE CORPORATION OF CANADA, LTD., BELLEVILLE, ONTARIO

cate with any one of the remote stations without being overheard by the other units. A control adjusts the speaker volume to any desired level. Radiofone Corp., 136 West 22d St., New York.

Electrode Holder

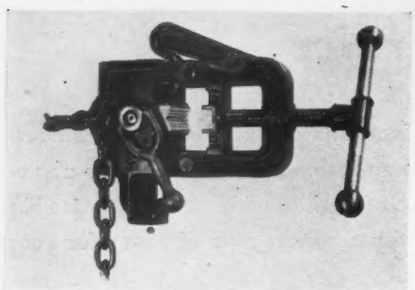
Tweco electrode holder is light in weight and cool running. It has a completely insulated spring tensioning member that is inclosed and out of the way. Spring tension is adjustable to suit the strength of the operator or size of electrode. Holder



jaws have electrode lock from which the rod cannot fall out of position. Handle grip, guard, and trigger are shockproof. Replaceable copper jaw tips. Tweco Products Co., 111 West 3rd St., Wichita, Kansas.

Pipe Vise

"Post" vise locks pipe to any column or post up to 10 in. in diameter. It is equipped with a pipe bender which takes pipe up to ¾ in. Model 163 has broad-jaw hinged vise, and Model 152 has broad-jaw, side-open vise. Armstrong Mfg. Co., Bridgeport, Conn.



Portable Elevating Table

This table can be raised or lowered to correspond to height of machine tools or work bench. By means of a 24-inch-diameter handwheel the table top can be set at any height between 24 and 38 in. from the floor. The worm locking device maintains height constant. A quick-acting floor locking device can be furnished to hold table stationary. Capacity is 4,000 lb., but tables in any capacities, heights, and shapes can be built to specification. Standard tables are equipped with 4-in. ball-bearing swivel casters. Heavy-duty casters can be furnished in larger sizes. The Teeco Mfg. Co., 416 South Talman Ave., Chicago.

Wash Fountains

"Groupwash" fountains are made from 11-gage mild steel with 26-gage mirror-finish stainless steel liner. Base and tube under-plate are finished in smooth enamel. Easy to keep clean; needs only to be wiped off lightly with a rag. Can accommodate ten people. Has automatic mixing unit so that water is at right temperature, and

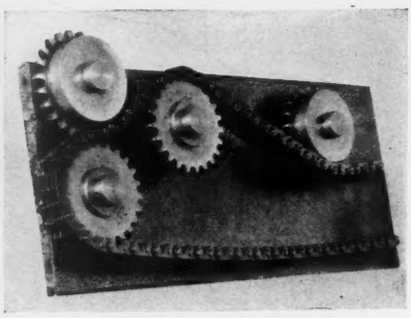
five handy controls. Tub sections are demountable so that units can be easily installed and taken down. Sugar Beet Products Co., Saginaw, Mich.

Resin

"Paradene" is a thermoplastic resin made in three grades having different melting points. No. 1 melts between 75 and 99 deg. C.; No. 2 between 100 and 124 deg. C.; No. 3 between 125 and 140 deg. C. Soluble in coal tar solvents. It softens upon heating, becomes plastic below its melting point, and fluid above it. Stable to approximately 200 deg. C., but slowly decomposes from prolonged heating above this temperature. Chemically neutral, it resists water, alkalies, and dilute acids. Can be used with aluminum vehicles, impregnating compounds, rubber compounds, filling, calking and sealing compounds. Neville Co., Neville Island P.O., Pittsburgh.

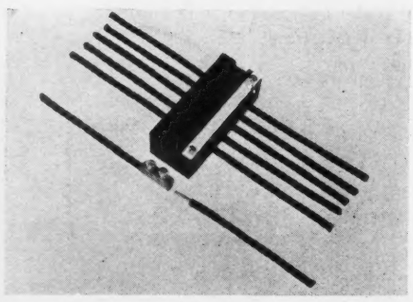
Chain

Duplex chain resembles in appearance two narrow side guide chains so constructed that the links of each are pointing in opposite directions for the purpose of driving sprockets from each side. Nar-



row-faced sprockets are used, engaging but one-half the chain, with their hubs supporting the other half not in engagement. Intended for operation of groups of rolls or other installations where sprockets must be placed close together. Ramsey Chain Co., Inc., Albany, N. Y.

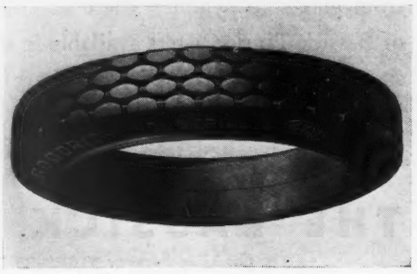
Terminal Blocks



Type 1, Series 1000 terminal blocks are made of molded plastic. They come in 4-, 6-, 8-, or 12-wire sizes and can be furnished with or without covers. Connectors are small fittings inserted into the block after molding and the wires are held by a screw and spring clip. The small block is rated 30 amp. and 750 volts maximum. Burke Electric Co., Erie, Pa.

Tire

"Oil-Pruf" tire is specially compounded to resist action of animal, vegetable, and mineral oils. It is said that the new com-



MECHANICAL POWER
TRANSMISSION EQUIPMENT
"To Fit Your Needs"
MEDART
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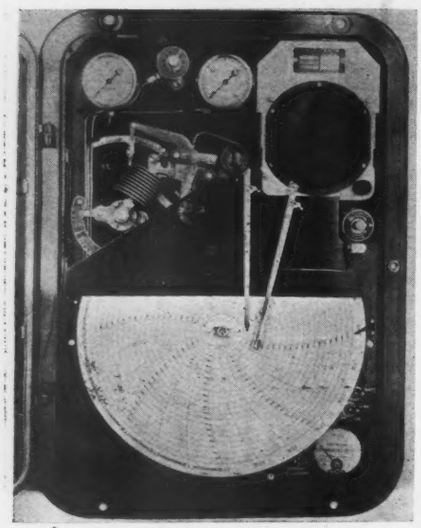
pound used gives better tread wear in normal service and better tread wear in service where cutting and abrasion are severe. Tear resistance has been improved and adhesion of the tread to the metal base is better. The B. F. Goodrich Co., Akron, Ohio.

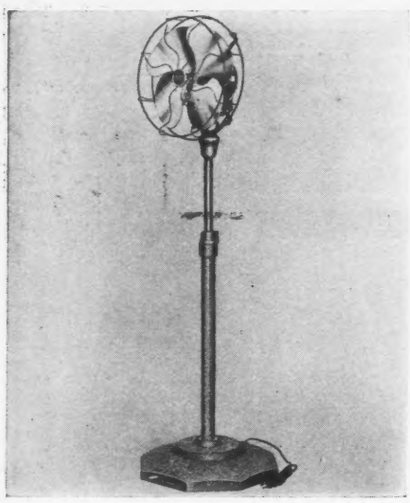
Controller



"Pyromaster Reset Potentiometer Controller" can be used for automatically controlling temperatures up to 3,000 deg. F. Offered as a pyrometer and as a resistance thermometer. Record of the controlled temperature is made on 12-in. circular chart. No lubrication of the operating mechanism is necessary. The galvanometer is completely inclosed in a case and is said to be unaffected by excessive vibration. Operates on free vane principle of air-operated control. User can change throttling range and rate of reset over a wide scope through simple adjustment. The Bristol Co., Waterbury, Conn.

Fan

Type 77646-AD 12-in. oscillator fan on adjustable floor stand. Stand is of rich mahogany lacquer finish and blades are highly polished aluminum, making it an attractive unit. Three-speed sliding switch. Stand is adjustable from 3 ft. 3 in. to 4 ft. 9 in. Emerson Electric Mfg. Co., St. Louis, Mo.



Truck

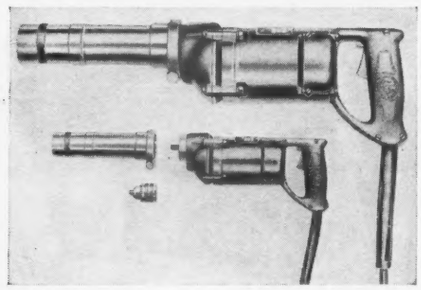
"Grab-It" drum truck provides easy transportation of standard 50-gal. drums weighing from 50 to 700 lb. Device automatically grabs the drum; tilting the handle raises it to transporting position, and automatically releases it at destination by tilting handle forward. When operator moves truck in against drum, grab members grip firmly just under the bottom ring. If handle is tilted forward, the members lift on the ring and cause the drum to be elevated. Has roller-bearing iron wheels. Wash Co., 720 Bowman Ave., Danville, Ill.

Switch

Bulletin 4101 "Current Breaker" mill duty switch is available with a window in the cover to make inspection of the blades

possible from the outside. Available in standard sizes from 30 to 1,200 amp. up to 600 volts, fusible and non-fusible. Cutler-Hammer, Inc., 253 North 13th St., Milwaukee.

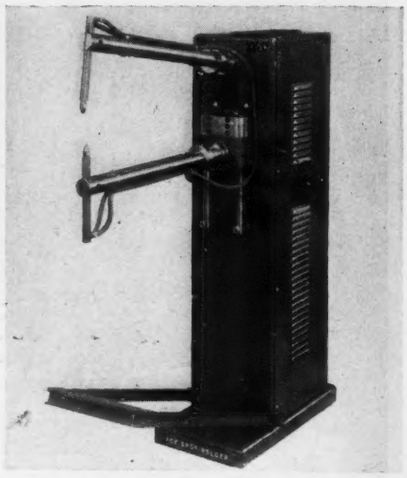
Electric Drills



No. 200–2700 heavy-duty universal drill can be converted in a few seconds to a self-rotating hammer drill of ½-in. capacity. Can be used for light chipping by applying a lock collar to stop rotation. Equipment includes a 3-jaw chuck and one drill steel. Chicago Pneumatic Tool Co., 6 East 44th St., New York.

Welders

"Ace Spot Welders" can be used in maintenance work. They are said to be easy to operate. Pressure on the foot treadle closes the upper electrode upon pieces to be welded,



pressing them firmly while a heavy current passes through. Several sizes: Kw. ratings vary from 5 to 20; throat depths from 6 to 36 in. Pier Equipment Mfg. Co., Welding Equipment Division, Benton Harbor, Mich.

Voltmeter

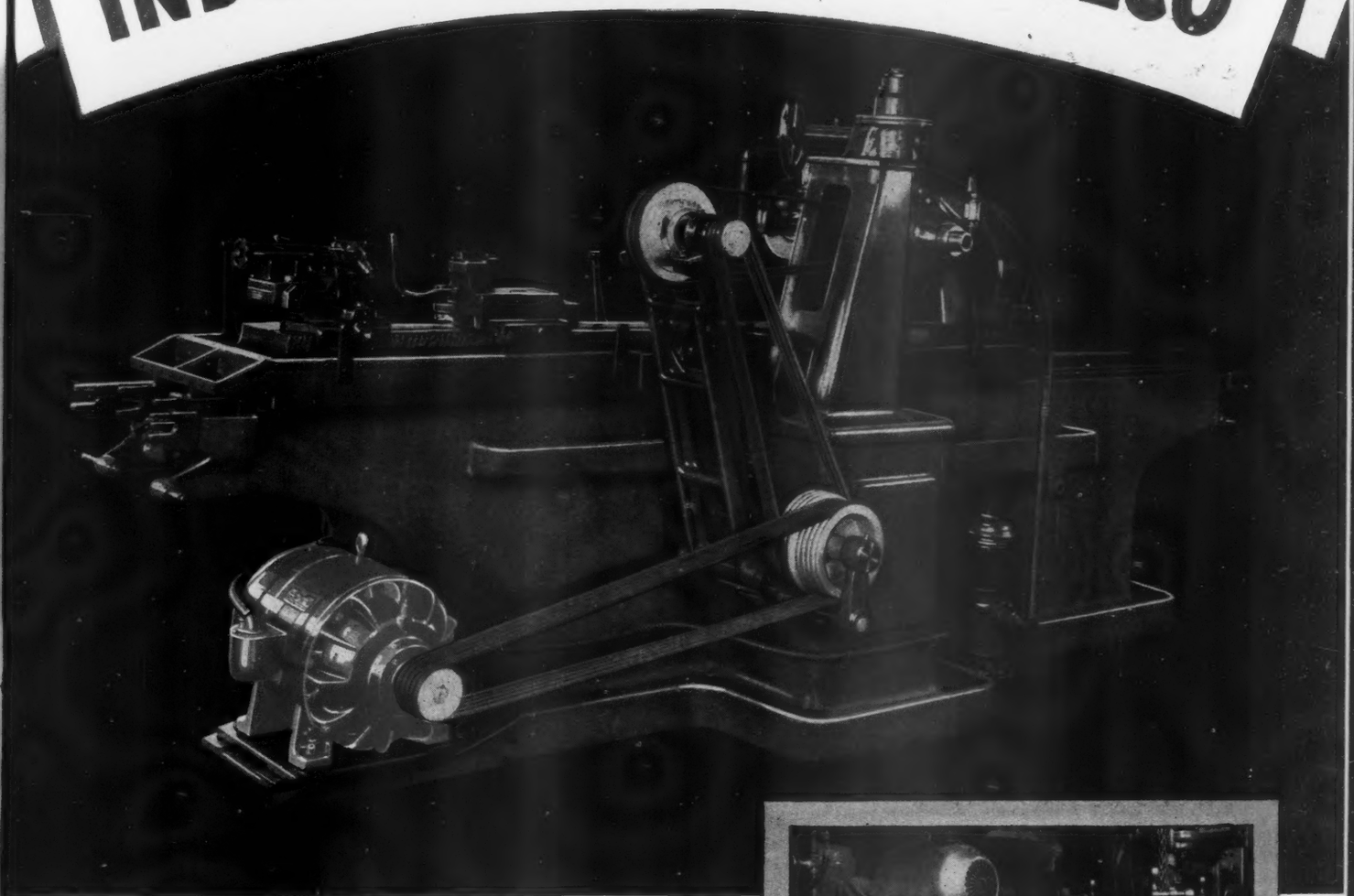
"Voltor" is a voltage attachment for the company's "Tong Test" ammeter. With it both a.c. and d.c. voltages up to 600 volts

can be measured. Three full ranges: 0-150, 0-300, and 0-600 volts. Designed for use with any existing 50-amp. element of either type A or AX Tong Test or 75-amp. element of the type B or C. Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland.

Hogs

No. 12-C series hogs are designed for use in reducing combustible rubbish in the medium- or small-sized plant. They are of all-steel construction, equipped with extra

INDUSTRY TURNS TO DELCO

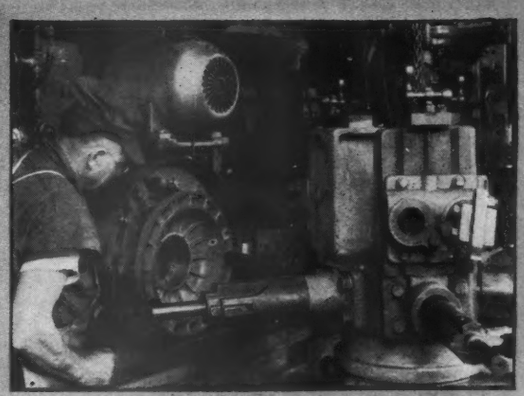


DELCO SEES THE PROBLEM FROM BOTH SIDES OF THE FENCE

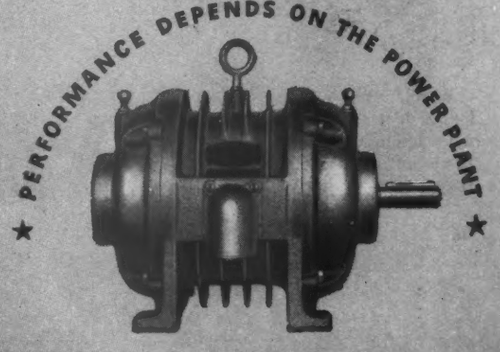
In the Delco Products factory at Dayton there are many specially built machines to assure the proper alignment and precision manufacture of Delco motors.

Delco engineers design these machines, and lay down the specifications for the Delco motors which power them. They are as exacting in their demands as any other plant engineers would be, because the efficiency of the plant and the quality of the product depend upon the satisfactory operation of these applications.

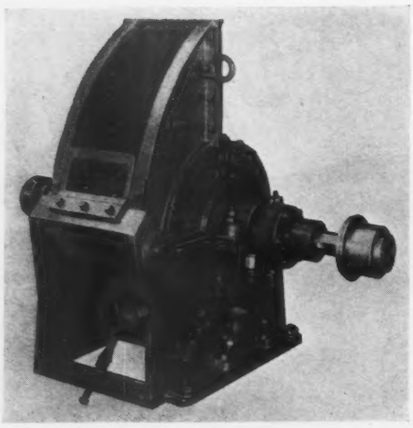
In this way Delco is constantly in touch with the point of view of men who use Delco motors . . . because Delco is itself a user. This has been a factor in bringing about many improvements in motor construction . . . improvements which have helped establish the fact that Delco motors are "built to do the job." Delco Products Division, General Motors Corporation, Dayton, Ohio.



Specially built machines make it possible to perform turning operations on the end frame, and turning and boring operations on the ball bearing retainers, in one set-up each. Delco ball bearing retainers are machined to tenths of a thousandth of an inch. This makes possible the proper fit of a selected bearing.

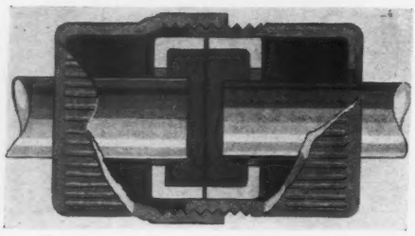


DELCO MOTORS



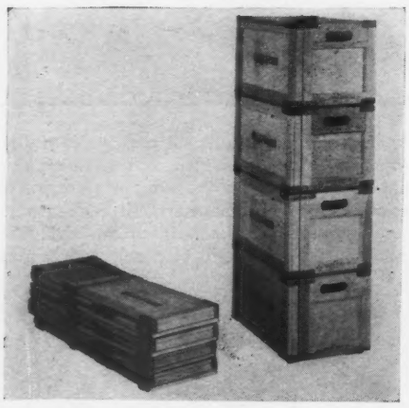
large shafts and oversize roller bearings. They have safety features which throw out any large tramp metal without injury to the machine. Made with two types of cylinders; one is a shear-blade type for handling combustible refuse of all descriptions, containing nails, band iron, etc.; the other is a flat-faced, sharp-knife type which is used for grinding wood paste, paper stock, etc. Either type can be furnished with or without screens at the discharge for controlling the degree of fineness of the reduced material. Mitts & Merrill, Saginaw, Mich.

Flexible Couplings



"Torflex" is a flexible coupling in which power is transmitted from the driving to the driven shaft through rubber bushings which are bound by pressure to the shafts. Provides full transmission of power, even when shafts are in great angular or parallel misalignment. Available for shaft sizes up to 1½ in. in diameter. Gordon Engineering Co., 3576 Gratiot Ave., Detroit.

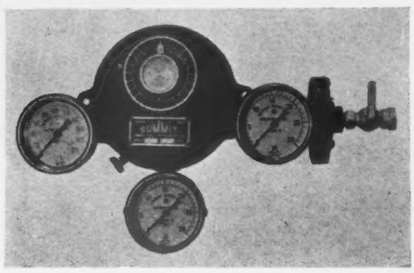
Tote Boxes



Wooden folding tote boxes are made of beech, birch, and maple plywood reinforced with laminated northern elm. Fittings are rustproof hardware. Can be used as temporary stockroom bins, and when not in use, fold up to approximately one quarter of their set-up space. Boxes stack securely one on top of the other and have metal skids at the bottom. They can be stacked several high and skidded along the floor. John G. Elbs, Inc., 1037 Jay St., Rochester, N. Y.

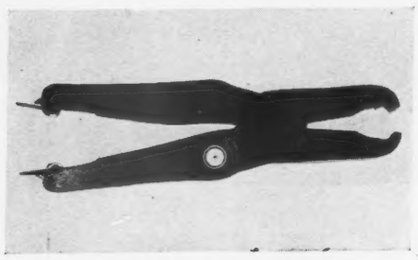
Controller

"Summit" automatic, air-operated pressure controller maintains constant pressure on equipment to which it is connected. It is sensitive to less than ¼ lb. pressure change, it is said. Can be mounted either



on diaphragm top of valve or on a panel located near the valve. Has independent, adjusting knurled knob with pointer. There is no interruption of pressure when adjustments are made. Furnished complete with three gages to indicate all operations. Can be changed from direct to reverse acting without removal from mounting. Industrial Instrument Co., 96 East Miller Ave., Akron, Ohio.

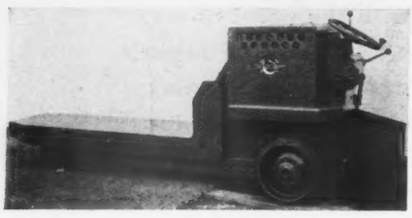
Fuse Tester and Puller



"Star Test Plier" is a combination test lamp and fuse puller. Made of laminated fiber, its double-end design is intended for pulling plug fuses at one end, and testing at the other. Small test lamp is located in the middle and may be readily replaced by removing the cover. Will grip any size fuse from 30 to 200 amp. For use on 110-600 volts. Star Fuse Co., Inc., 235 Canal St., New York.

Truck

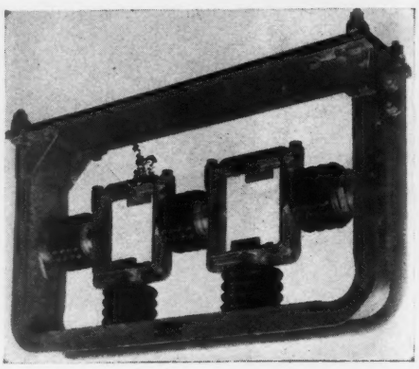
Type NDTE-10 low-lift, elevating-platform truck has capacity of 10,000 lb. and a lift of 6 in. Six-wheel steer by means of a handwheel. The truck with a 36x60-in. standard skid will operate through box-car doors. Platform is raised by two roller



chains. Operated by a heavy-duty electric motor which draws its power from a battery. External contracting brake is operated by foot pedal. Has automotive-type springs. Can travel 5 to 6 m.p.h. light, 3½ to 4 m.p.h. loaded. Elevation of 3½ sec. empty, 6 sec. loaded. Has electric horn operated by footbutton. Crescent Truck Co., Lebanon, Pa.

Bus Support

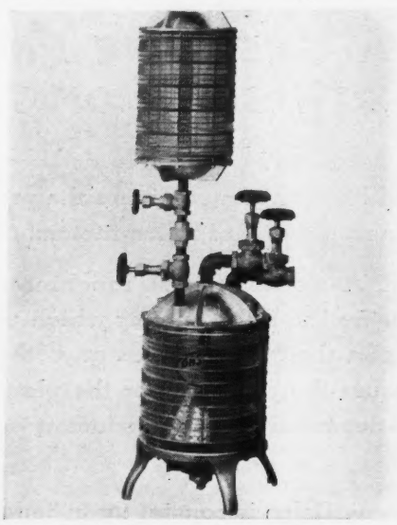
Two sets of twelve 6x1¼-in. bars with wide spacings between groups of six each are carried on wet-process insulators in compression. Clamps are provided with rollers and springs permitting bus expansion and contraction. Steel frame is in-



stalled on bottom flange of floor beams by means of ⅝-in. bolts and beam grips. Adjusting nuts between frame and end insulators insure rigidity of the supports without the use of spacers. Designed to withstand heavy short circuits with ample safety factors. Delta-Star Electric Co., 2400 Block, Fulton St., Chicago.

Automatic Fluxing Machine

This machine automatically dispenses brazing flux. The gas line runs through the "Gasfluxer," and as it passes through is impregnated with a special flux. The flux



then travels with the gas to the torch tip and is expelled in the flame. The special flux used has a very low melting point and is dispensed in a minimum quantity. It creeps ahead of and is always under the brazing puddle, it is said. It is claimed to penetrate thoroughly and quickly, and makes possible a very tight weld. By accu-

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rate measurement of the flux used this machine makes possible low-temperature brazing. It is especially valuable when dissimilar metals are to be joined. Can be used with all types of equipment, as well as any standard gas. Automatic Gasflux Co., 620 Frankfort Ave., Cleveland.

Hoist

"Cum Along" lever puller and hoist can be used in any position and holds the load at any point. Made in two sizes, ¾- and 1½-ton capacities. It is light in weight and easy to move about. Handle telescopes to short length for use in cramped quarters. Latch release permits rapid movement of chain. The Harrington Co., 17th and Callowhill Sts., Philadelphia.

Controller

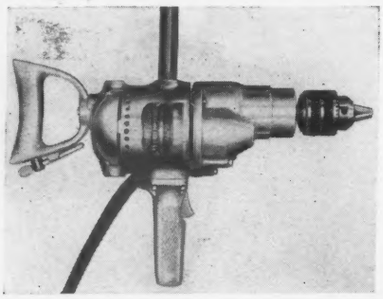
"Proportioning Controller" proportions fuel input to demand, controls and indicates temperature. As desired temperature is approached the input is gradually decreased and fed only in proportion as it is needed. Provides constant, even temperatures. Consists of an electrical device

mounted integral with the indicating controlling pyrometer. Operating function is entirely electrical. Wheelco Instruments Co., 1929 South Halsted St., Chicago.

Pipe Coupler

Self-sealing pipe coupler is a one-piece coupler constructed of a single piece of steel containing within itself two cup-rubber gaskets, so placed that the pressure of the water in the pipe automatically seals the joint against leakage at any pressure up to the bursting strength of the pipe. For water lines, gaskets are made of a live rubber composition. For oil, gas, and certain chemicals, Neoprene gaskets are used. Made in sizes from 1 to 20 in. inside diameter. R. H. Pierce Mfg. Co., 245 Blair St., Eugene, Ore.

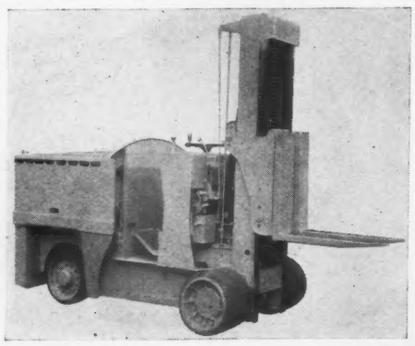
Electric Drills



"Utility Power Drill Line" consists of large-size drills which give heavy-duty performance. Come in three sizes: ⅝, ¾ and ⅞-in. Capacities in steel run from 5/32 in. to ⅞ in. Capacity in hard wood from 1¼ to 1¾ in. No load speeds range from 300 to 200 r.p.m.; full load speeds, 175 to 120 r.p.m. Standard voltage 110; also available for 220 or 250 volts. The ⅝-in. drill is also available for 32 volts. The Black & Decker Mfg. Co., Towson, Md.

Trucks

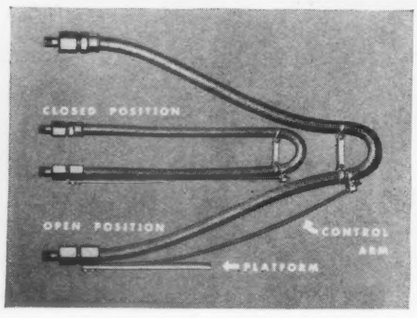
Model K-41 truck comes in ram and fork types and in capacities from 8,000 to 16,000 lb., with end or center control. Drive wheels



are of the non-skid type and are on the load end of the truck. Steering trailer wheels are under the battery, and are designed to give a very steep angle of steer to reduce turning radius to a minimum. Yale & Towne Mfg. Co., 450 Tacony St., Philadelphia.

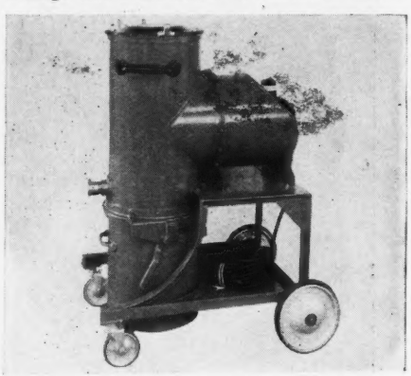
Hose

"Packless Flex-Control Self-Draining Hose for Platen Press" has a control element which consists primarily of a small, compact platform and control arm which are rigidly fastened to the coupling. They are designed to take slack and water pockets out of the hose automatically, assuring positive drainage. Three styles are available to take care of long or short platen travel, and wide, medium, or zero opening while in closed position. Hose has woven-asbestos jacket which completely encases high-tensile, bronze hose braid. Packless Metal Products Corp., Long Island City, N. Y.



Vacuum Cleaner

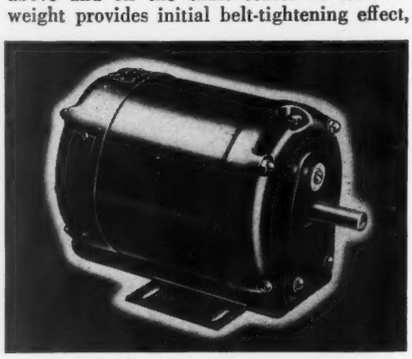
This ¾-hp. heavy-duty, portable vacuum cleaner has an inclosed tubular dirt bag which can be cleaned without removing it from the machine. This prevents dust flying around when the bag is cleaned. There is a large dirt container which makes unneces-



sary frequent cleaning of the machine during the cleaning operation. It can be operated on a.c. from 25 to 60 cycles, 110-220 volts; also on d.c. Mounted on wheels and casters. The Spencer Turbine Co., Hartford, Conn.

Motor

Belt-tightening motor for over-drives such as furnace blowers where the belt must pull on top side of pulley. Motor is supported above and off the shaft center so its own weight provides initial belt-tightening effect,



but this is increased proportionally to the load by the reaction of the rotor to the stator, causing the motor to swing away from its load and tighten the belt the proper amount. Also available is a belt tightener without springs for under-drive belts. In these the motor is resiliently supported off and below the shaft center. The Ohio Electric Mfg. Co., 5914 Maurice Ave., Cleveland.

Pump

Pumping unit for bulk transfer service where both thin and highly viscous liquids are handled. Pump is of herringbone-gear-impeller type driven by a constant-speed

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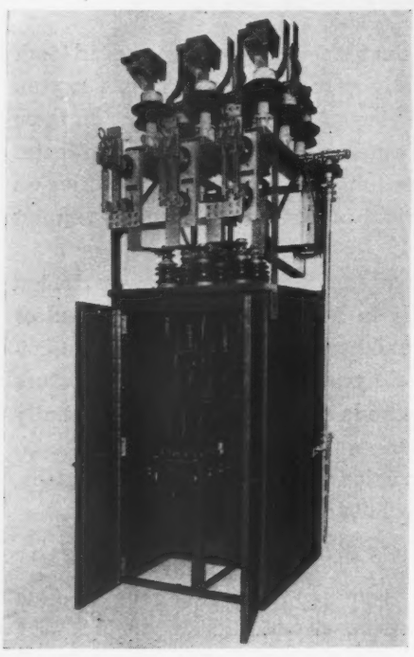
motor or internal combustion engine through a two-speed inclosed transmission. Speed may be varied, depending upon viscosity of the liquid handled. In all cases, full power of the motor is used. Pump is self-priming and has high suction. There are no valves, and the entire unit requires little space. Worthington Pump & Machinery Corp., Harrison, N. J.

Valve Operating Mechanism

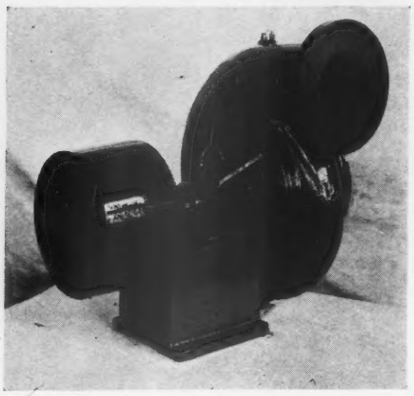
Type 1, Model C valve operator for slip-stem valves is available with strokes from ½ to 10 in. and speeds from 3 to 10 in. per min. Has power release device which accurately positions the valve at open and closed positions regardless of variable motor drift. Can be used for open to closed operation or for automatic control with incremental movement. Housing can be made explosion-resisting. Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia.

Switchgear

Out-of-door 5-kv. steel switchhouse with top switch rack occupies ground area of 7 ft. x 8 ft. 6 in. Incloses a 15-kv., 2,000-amp. oil-blast circuit breaker with instrument transformers and panel equipped with control switch, indicating lamps, instruments, relays, and test switches. Primary connections are brought out through a non-magnetic roof supporting sealed-type roof entrance bushings. Six vertically mounted hook-stick switches serve to disconnect the circuit breaker from the line. Horizontally mounted three-pole switch on top of the framework and operated from ground level bypasses the equipment, insuring service continuity during testing and inspection periods. Delta-Star Electric Co., 2400 Block, Fulton St., Chicago.



Pumps



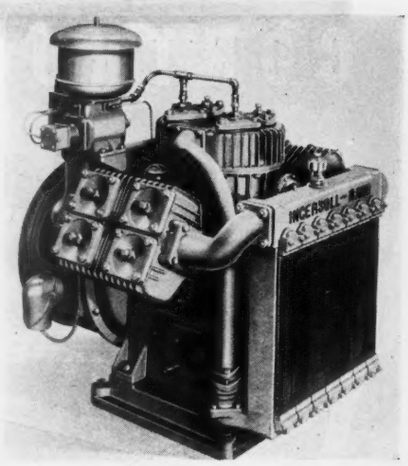
Figures 3610 and 3612 single-stage, side-suction, ball-bearing centrifugal pumps. There are 18 sizes in capacities from 5 to 1,800 gal. per min. against heads up to 110 ft. Flat- or V-belt or direct-motor drive. Goulds Pumps, Inc., Seneca Falls, N. Y.

Conveyor Chain

No. 4250 swivel chain is a flexible, quickly detachable conveyor chain that will travel around curves of as small a radius as 12 in Applicable to the handling of cases, cartons, crates, cans, and other small units. Link-Belt Co., 220 South Belmont Ave., Indianapolis.

Compressor

"Motorcompressor" is a stationary, vertical, single-acting, two-stage air compressor. Intercooler and radially-placed cylinders are air-cooled. Combines motor and compressor as a single compact unit. Compressor crankshaft carries the motor rotor and the compressor frame carries the motor stator. Flexible coupling and V-belt drives are also available. Sizes range from 15 to 75 hp. for discharge pressures from 80 to 125 lb. per sq.in. Piston displacements range from 79 to 445 cu.ft. per min. Ingersoll-Rand, 11 Broadway, New York.

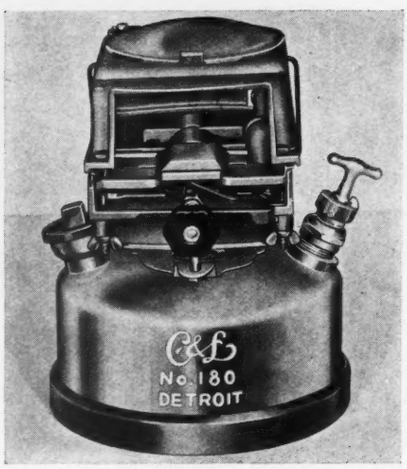


Machine Guard

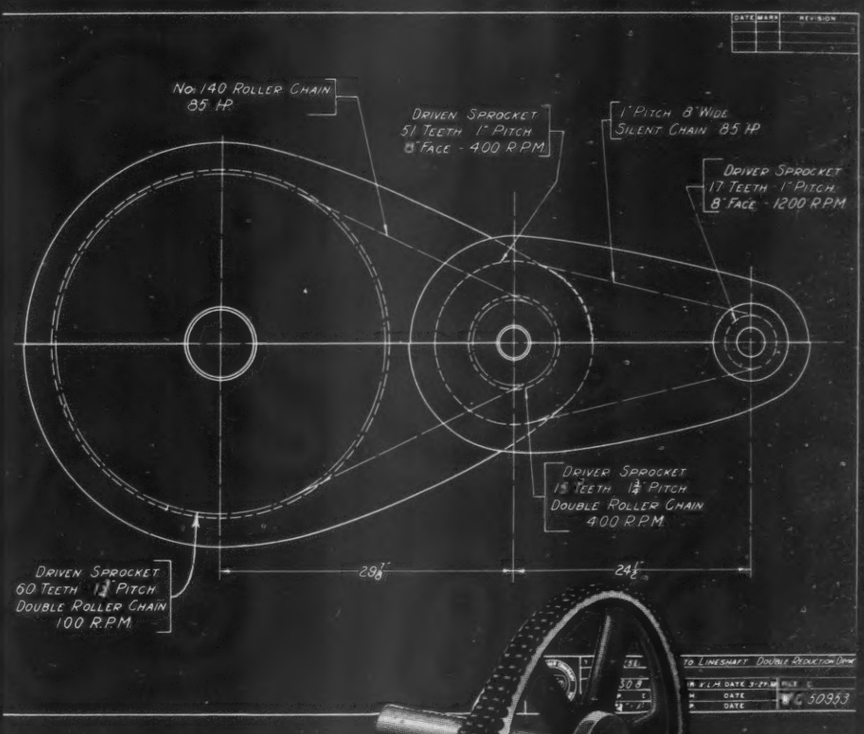
Where visibility of the operation is important, transparent "Plastacele" sheeting can be used for machine guards. Available in any thickness, it can be cut to fit any shape frame, bent to suit any contour, and drilled or punched for bolt or rivet holes. If the surface becomes scratched or dirty, it can be washed clean. It is said to have long life and low inflammability. Oils in general have no particular effect unless the material is completely submerged for a period of time. E. I. duPont de Nemours & Co., Plastics Dept., Arlington, N. J.

Fire Pot

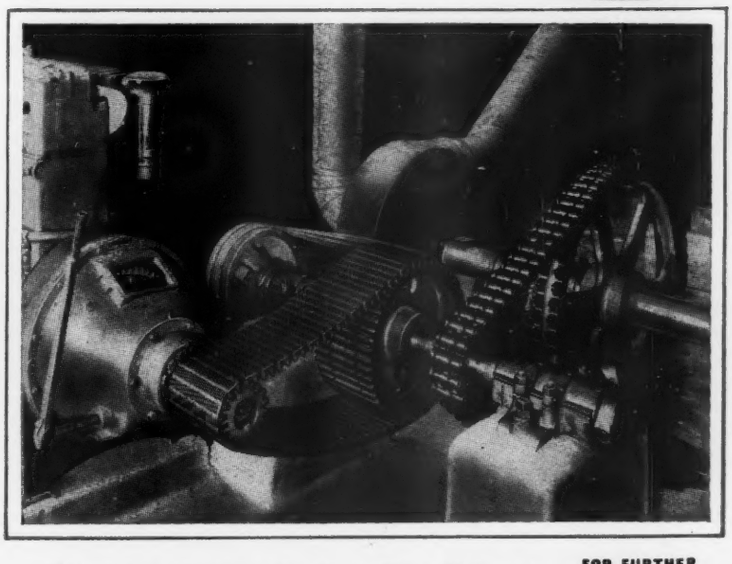
No. 180 silent fire pot will heat a pair of 12-lb. soldering coppers and a pot of metal at the same time. It is equipped with a tank having a capacity of one gallon of gasoline. The burner is E-shaped with air and gas mixing tubes in the center bar. The twin flames coming from heavy screens set in the sides of the outside bars play towards the center bar on which rests the flame detector plate. Clayton & Lambert Mfg. Co., French Road & Madola, Detroit.



This MORSE CHAIN INSTALLATION



Costs less Saves Space



This photograph shows the Morse Silent Chain and Morse Roller Chain installed on the diesel engine driven rubber mill. Note the compact, clean arrangement. (Chain cases and oilers are removed for complete views of chains.)

This clean and compact double reduction Morse Chain drive was installed for less than one half the cost of a gear speed reducer. Replacing flat belts, these chains drive a rubber mill line shaft from a diesel engine more efficiently and save both space and money.

The drive consists of a Morse 1" pitch 8" wide silent chain on a Morse 1¾" pitch double strand roller chain. Greatly increased production resulted when these Morse drives took over their job of power transmission. The print above shows the drives, and the photograph at the left, the installation.

Morse Positive Drives operate with efficiencies up to 99.4%. They are convenient and adaptable in installation and will do outstanding jobs of this sort on many installations. Consider Morse drives for your plant so that you too may benefit from these *better* drives.

The Morse man in your territory is ready to consult with you on every power transmission problem, and back of his experience is that of forty years of successful power transmission with Morse drives.

FOR FURTHER INFORMATION
SEE OUR CATALOG IN SWEET'S

SILENT CHAINS ROLLER CHAINS FLEXIBLE COUPLINGS KELPO CLUTCHES

MORSE *positive* DRIVES

MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.

Operating Shorts

Helps Workers Keep Track of Production and Shipments

ALDO MARIO DE AZEVEDO,
Director, Fabrica Japy S.A.
Sao Paulo, Brazil

A simple but effective method of keeping the personnel of our cotton textile factory informed about production, shipments, and so on is shown in the illustration.

It takes the form of a model about 7 ft. long, which is inclosed in a glass case and placed in the main entrance of the mill. The slogan above it may be translated: Follow and Help Factory Business Progress. Elements of the model and their significance are:

At the left, a brick structure, representing the factory.

At the extreme right, a target, representing the goal.

In the background is a time scale represented by the first six months of the year. The second half of the year is shown by reversing the cards.

The airplane represents Time—which is always flying. It is painted golden yellow, in pleasant contrast to the sky-blue background.

The locomotive represents shipments, all of which are made by rail. Scale for shipments is in kilometers of cloth, and is the same for production. Total value of the scale at the front is 1,000 kilometers, representing the normal output in six months.

The automobile represents production.

Relative position of the airplane, locomotive, and automobile, which can easily be shifted, shows at a glance how production and shipments stand with respect to time.

As indicated at the beginning, this model was designed to accomplish the following objectives:

1. To give our 400 employees an overall picture of shipments made with respect to time, and production with respect to shipments, which will show an increase or decrease of stocks.
2. To increase the *espirit de corps* and interest in factory operation, which is closely related to the employee's work and wages.
3. To foster the spirit of competition through the race of the automobile and airplane, or production relative to time.
4. To make detailed explanations unnecessary when we have to increase or shorten the working hours.

We feel that this model has served these purposes very satisfactorily.

Mr. de Azevedo's contribution has been awarded the $15 payment offered by the editors for the best Operating Short submitted during the past month.

•

Rotary Wire Brush Does a Good Cleaning Job

JOHN E. HYLER, *Peoria, Ill.*

One of the hardest cleaning problems one is likely to meet is the removal of old paint, rust, scale, or accumulations of grease and dirt from large and bulky equipment, such as machines, tanks, and the like. The portable, rotary wire brush, either air- or electric-driven, is a splendid tool for the purpose. Of course, goggles must be worn when using it, for the dirt is sent flying in most cases.

This same brush can be used to advantage in preparing new surfaces for finishing; roughness and spattered metal can be effectively removed. For heavy, welded machinery this is especially true. One manufacturer of heavy, grading equipment uses the rotary wire brush for this purpose all the time.

Units of this type can be procured from firms specializing in finishing equipment and those dealing in portable power tools.

In spray painting, areas coated with glycerine will not take the paint, can be wiped clean after painting.

Small Boilers Handle Varying Heating Load

SOURCE, *Campana Corp., Batavia, Ill.*

Any plant in a cold climate has wide variations in the heating load. At this plant, provision has been made for this condition by an extraordinary type of installation.

The factory has approximately 85,000 sq. ft. of floor area; hence does not require any large number of big boilers for the heating load — and power is purchased outside. With a large boiler it would be necessary to use two or three oil-burning units. Shutting down one or more of these burners, leaving a large cold area in the firebox, would certainly not lead to efficient heating, the engineers felt when they laid out the plant.

After a good deal of preliminary figuring, they decided to install 12 domestic-size oil-burning furnaces—the kind that might go into a private home of moderate size. These small boilers send their steam into a common header, then to an interchanger.

The furnaces are arranged in banks of three. In midwinter, with the heating load at peak, the furnaces are cut in by threes. In other seasons, it is

...The reflection of
Gaylord Leadership

GAYLORD CONTAINER CORPORATION

General Offices: SAINT LOUIS

Hedrich-Blessing Studio

possible to back out a fuse in each box and cut the operating furnaces down to pairs.

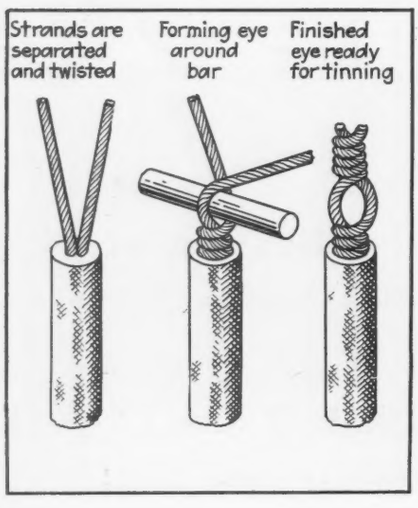
This installation cost about 25 per cent more than a boiler of sufficient capacity to heat the building at peak load. Experience shows, however, that these small boilers are at least as efficient at peak load as a big boiler would be. At lower loads, they are very much more efficient—and the figures indicate that the excess investment will amortize itself in a very short time.

•

Emergency Substitute for Terminal Lug

CHAS. H. WILLEY, *Penacook, N. H.*

Occasions arise, particularly in emergencies, when the right size of terminal lug is not available. If the wire or cable is stranded and the terminal will not be subjected to unusual temperatures, an effective substitute for a lug can easily and quickly be made as shown in the illustration.



As will be seen, it consists of an eye that is produced by separating the strands into two parts, and forming them around a bar of suitable size. If the eye is heavily tinned after forming it will be satisfactory for most purposes.

•

Mark Load Limit on Floors and Beams

S. H. COLEMAN, *Roanoke, Va.*

Danger of exceeding load limits of floors and beams can hardly be over-emphasized. Many a good floor has been cracked, or completely caved in, by subjecting it to loads 'way beyond its capacity. In the case of beams, too, someone is likely to clamp on a hoist and lift some object so heavy that the metal is distorted and the whole structural framework is pulled out of line.

This kind of thing is particularly likely to happen to roof trusses which are usually designed to support only the roof and a uniformly distributed load of snow or water, but are not intended to take a heavy stress at any one point.

Realization of these hazards both to structures and to personnel has led one company to adopt the policy of stenciling the permissible load limit on the walls in each area. A white square is first painted on, and the load limit marked with black figures, so that they stand out prominently.

All beams supporting permanently mounted hoists, and those to which hoists can be attached, are stenciled "Not Over —— Lb." with black paint when the metal is protected with aluminum paint, or with yellow paint when the background is green. Walls near the points where loads are attached to the beams carry a similar sign. Beams that are stenciled in this way must not be used to support hoists.

As a further precaution against overloading it is required that before a beam may be drilled for any purpose, as when installing a pipe line or electrical conduit, permission of the structural engineering department must be obtained. The same rule must be observed when a temporary excess load is to be placed on any floors, so that they can be given additional support if necessary.

Permanently connected in the motor circuit, an ammeter will show at any time whether or not equipment is operating at capacity.

Putting Byproduct Power to Work

SOURCE, *Detroit Diesel Engine Division of General Motors Corporation, Detroit*

Byproduct energy is teamed with that generated in the power department to operate this new plant. Admittedly, not many plants have a set-up that enables them to obtain free power as a result of operations carried on for other purposes. But there may be an idea in what this plant is doing.

Laboratory facilities for research and development are housed in the same building as the power department, for an excellent reason. The laboratories contain eight dynamometer rooms, in each of which a diesel engine is normally under test. These engines are tied into the generating system. So, also, are the engines that are being run in and tested in the production building. Thus, the greater the volume of testing, research, and experimenting, the greater the volume of free power, and the lower the load on that portion of the power generating epuipment that

•

Special Notice

$15 will be paid for the best Operating Short submitted during the month of April. The Editors are the judges. Other Shorts accepted will be paid for at attractive rates

A PENCIL

● No, it's not encrusted with rubies. Nor is it made of platinum. Just an ordinary pencil—but placed in the hands of YALE engineers, it has saved industry millions of dollars yearly.

● Always first, YALE engineers originate what others copy. From their fertile brains come the advances that make YALE Hand Lift Trucks the world's most efficient units of their type.

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● Ranging in capacity from 1,000 to 20,000 lbs.—one of these super trucks is just the answer for *your* handling problem. Put the million dollar pencil to work for you. The nearest YALE representative will tell you how.

The Famous YALE *BLUE STREAK* —Single Stroke Hand Lift Truck—2500 lbs. Capacity—(Narrow Frame Model.)

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PHILADELPHIA DIVISION, PHILADELPHIA, PA., U. S. A.
IN CANADA: ST. CATHARINES, ONT.

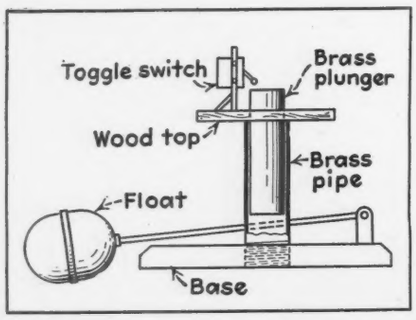
is set up specifically to power the plant, and energy is no longer wasted through resistance grids.

•

Flooded Motors Won't Get Wet Again

C. W. HOPE, *Lowell, Mass.*

After water had leaked into an underground pump room and submerged two motors, we decided to prevent a recurrence by installing a bell alarm. We also posted a notice to the effect that if the bell should ring, the power plant engineer was to be notified. He



could then take steps to pump the water out before it reached the motors.

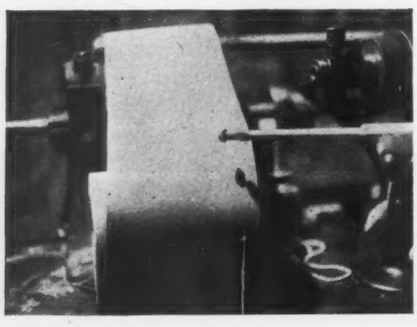
A float switch sets off this alarm. It consists of a metal base to which a brass pipe is attached. Within the pipe, resting on the float arm which passes through the pipe in two slots, is a brass plunger. This plunger moves through a hole in a wood platform attached to the top of the pipe, and as it rises actuates the toggle switch.

•

Blow Sandpaper Clean —It Lasts Longer

BRUCE MACINTOSH, *Braintree, Mass.*

Life of coated abrasives, such as belts, disks, and sheets, may be considerably lengthened by blowing out particles of the material being cut from between the cutting grains. These particles which fill up or load the abrasive paper, reduce the cutting efficiency. They are best removed with a compressed-air jet, or, if that is not available, with a hand brush.



How to Make Easy-to-File Template Layouts

H. L. MANNING, *Department of Industrial Engineering, Cornell University, Ithaca, N. Y.*

Our industrial engineering students make some 80 plant layouts a year. Layouts of the usual type, with templates fastened by tacks or pins, would require more room for storage than there is available. So we have evolved the following method which should have advantages for the plant that has many floor-plan layouts.

Machine templates are made on a heavy white bond paper with the machine outlined in heavy black. These can be used just as they are, or they can be backed with a light cardboard before they are cut along the outlines. When a layout may require considerable rearrangement, the latter method is to be preferred. Before cutting out, the various templates may be colored with crayons.

It was necessary to find some flexible method of sticking templates to the floor plan. Pins and tacks would not do as they make it impossible to remove plans from the boards. With glue or paste, templates could not be removed once they were in place. The material that met all requirements was rubber cement.

For a tentative plan, a small drop, generally applied with the end of a pencil, is sufficient. This will hold the template in place temporarily. When a satisfactory permanent layout has been arrived at, the templates can be removed, coated over their entire backs with cement, and then pasted to the plan.

Excess cement around the templates is easily removed by rubbing with the finger or an eraser. The cement acts as a gum eraser and helps clean up the plan. If at any time it becomes necessary to remove templates, this can be done by sliding a razor or knife blade underneath, and peeling them off from the plan.

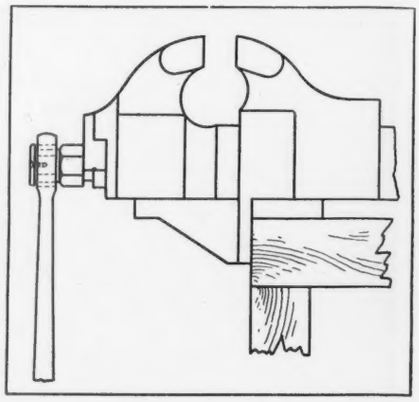
This arrangement has proved convenient since with it plans can be removed from the boards, rolled up easily. They take little storage space, and may be stored conveniently in blueprint file drawers. Some of our layouts are four and five years old, and the cement is holding as well as when applied.

•

Wrench Makes a Good Vise Lever

P. L. BUDWITZ, *Meriden, Conn.*

How a wrench may be applied to a bench vise to save motion is shown in the sketch. The vise user can easily adjust this type of lever to the most convenient position for tightening or releasing work in the vise. With the



conventional lever, the user often has to shift his position from one side of the vise to the other to apply proper pressure, because of the different positions the lever may assume.

A hexagon is milled on the head of the vise screw to receive a standard hexagon wrench. A portion of the head, however, is machined round, so that the wrench can turn freely on it. Then a washer is attached by a screw to the end of the head, the washer acting as retainer to prevent the wrench from dropping off. In operation, the wrench may be slid off of the hexagon portion, and swiveled to any position convenient for use.

It doesn't take a great deal of dust to clog intricate equipment and ruin quality products. How best to control it and to what degree, should be carefully determined.

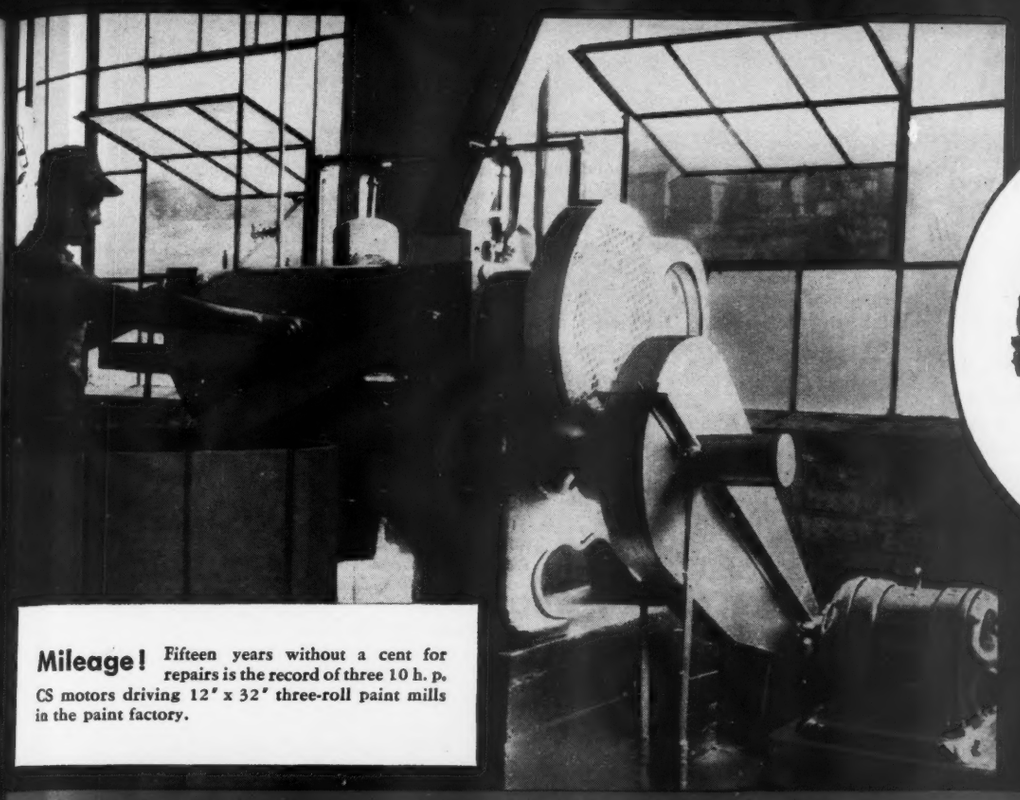
Canvas Lining Keeps Wooden Tanks from Drying Out

H. C. SLEMAN, *New York*

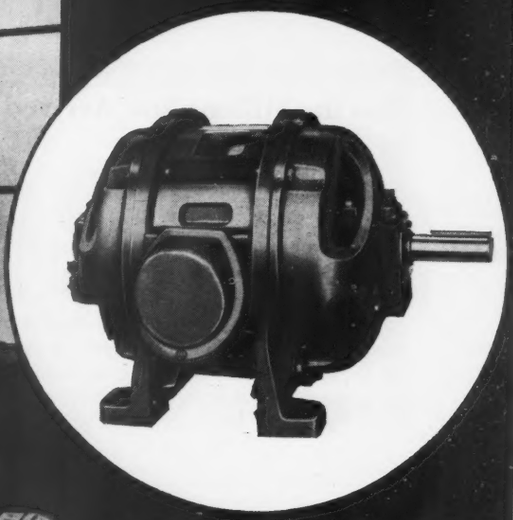
Wood stave tanks have a tendency to leak when they are filled after the liquid level has been low for some time. This is because the upper ends of the staves dry out and shrink, leaving cracks at the joints. Such leakage often creates an unsightly mess, and may result in needless waste of costly liquids.

Lining the inside of the wooden tanks with heavy canvas has been very successful in one plant in eliminating such leakage. Through capillary action the canvas draws up water even when the level is very low, thus keeping the upper ends of the staves wetted so that shrinking does not occur.

If heavy canvas is not available two or three layers of lighter material may be used. The cloth must be made to lay flat against the wood, and is best held in place by copper tacks having large heads.

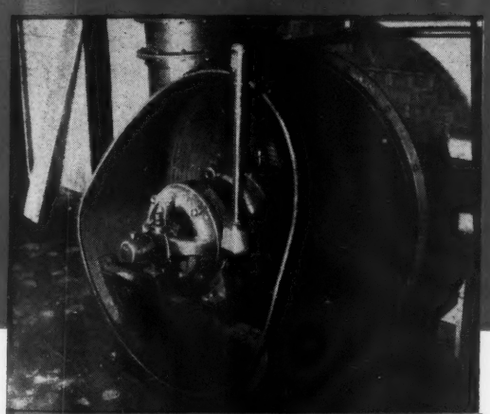


Mileage! Fifteen years without a cent for repairs is the record of three 10 h. p. CS motors driving 12″ x 32″ three-roll paint mills in the paint factory.

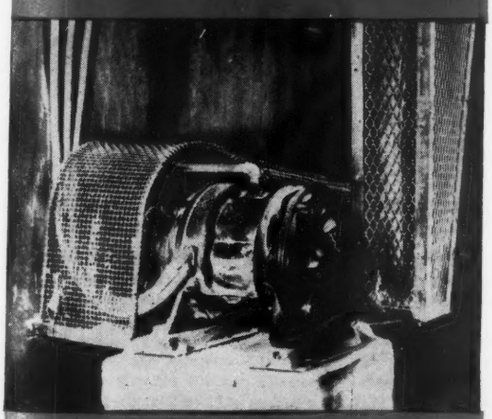


Convert the turning action of an electric motor into distance — you will be amazed at the mileage piled up during its lifetime. Extra years of service, extra mileage is built into Westinghouse motors.

MORE "Mileage" WITH WESTINGHOUSE



Mileage! Operating seven days a week for over eleven years, this motor has supplied air to a continuous kiln. Although exposed to coal dust, it has never been shut down for repairs.



Mileage! Driving a high speed mill in a ceramic plant, these motors run 9 hours a day at full load rating. The original windings and bearings are still intact, in spite of constant exposure to fine abrasive dust, during their nine years of service.

When buying a motor, specifications may be exactly right — but how about the mileage — the years of trouble-free service the motor will deliver?

You can be sure of mileage — of long life, low maintenance, and service under any and all operating conditions, when you specify Westinghouse.

For only Westinghouse motors offer the three essential features that mean More Mileage:

1. **TUFFERNELL INSULATION:** Dual protected windings and taped end turns give extra protection against mechanical and electrical damage.
2. **SEALED SLEEVE BEARINGS:** Exclusive Westinghouse bearing seal keeps clean oil in; seals dirt, dust and grit out.
3. **RIGID ONE-PIECE FRAME:** Mechanical parts carry the mechanical load, protecting electrical parts from vibration, torque and strain.

For full details on all types and sizes, simply call your nearest:

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FROM POWER LINE TO DRIVEN MACHINE
YOU ARE ALWAYS SURE WITH

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MOTORS * CONTROL * CIRCUIT PROTECTIVE EQUIPMENT

Has the Millennium Arrived in Australia?

(Continued from page 57)

declaration, socialistic. They want government ownership of the instruments of production. They want to achieve it by democratic means—the ballot—and say that they can hope to achieve it only if they are continued long enough in federal power.

In a word, the majority of voters over a considerable period will have to share labor's view before socialization can be accomplished.

It should be remarked at this point that government ownership has gone farther in Australia than with us. The telegraphs, the telephones, the railroads, trams and buses, and the chief radio stations are federal, state, or municipal owned.

Nor, no matter what some of the rank and file may think, do Australian labor leaders envision a paradise of light tasks should socialization be accomplished. They recognize that high standards of living are the result of efficient and large production. They state that this will require not only discipline but also incentive; and they have faith that pride of accomplishment, plus position, plus modest differentials for managerial skill will be incentive enough to get industry and agriculture properly manned and directed. But those, clearly, are critical questions, always in the perennial debate about state capitalism.

Looking to labor's profit from arbitration, it is pertinent to inquire whether it has shared proportionately in the increase in the nation's production and wealth. In fact, this question was put repeatedly to employers and to labor leaders. Generally the answer to this important question was, No.

Yet statistical inquiry revealed, first, that production per person engaged has gone up only about 15 per cent in Australia since 1911 and, second, that the real wage has gone up roughly in the same proportion. There was a decline in purchasing power during the war, at the very time when production was up, then an increase in the prosperous twenties, which, for those wage earners who are now fully employed, has thus far been maintained.

Labor Has Shared

Taking 1911 as the base, real wages have veried, since the War, from a low of 106.2 in 1923 to a peak of 118.5 in 1931, and for succeeding years have been as follows: 1932, 106.8; 1933, 117.8; 1934, 114.4; 1935, 113.3. In a word, labor has shared proportionately in the increase in national production, but that production has not increased rapidly.

It can, of course, be questioned whether the wage index base of 1911 represented an equitable distribution of the industrial income. On this point views vary. Some state that these wages were all that industry could bear, whereas others contend that manufacturing industries which could not stand a heavier wage bill should have gone under or had higher tariff protection. They found their case on Australia's responsibility to give human beings a respectable standard of living and they contend that basic wages have never been adequate for decent living and over and above that to provide for saving and home buying. The welfare workers generally hold the latter views.

Other Gains for Labor

Aside from wages, labor has had other definite gains. Hours have been shortened from 56 and 60 to 44; there are from 9 to 12 holidays per year with pay, substantial payments for overtime, and decided improvements in things

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● Ever since the world's first tri-motor electric crane was built in the P&H shops, more than 50 years ago, P&H has continued its leadership as America's largest builder of overhead handling equipment.

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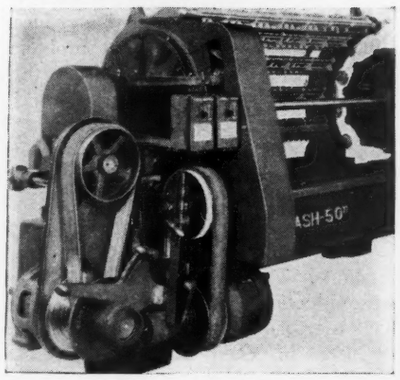
What's New
IN VARIABLE SPEED CONTROL

SANDING

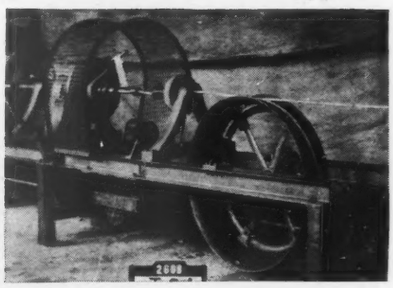


How REEVES Speed Control permits handling more shapes and sizes of product on the same machine is illustrated by this automatic sander. This machine is used in woodworking plants to sand turned wooden pieces of irregular shapes, ranging from ⅜″ to 6″ in diameter and from 2″ to 72″ in length. The sander is standardly equipped with two REEVES Vari-Speed Motor Pulleys. One controls the speed of rotation of the work piece according to its size, varying speed from 1,000 to 3,000 r.p.m. The other controls the speed of the revolving heads on which the work is mounted, thus controlling sanding time as these heads pass the work from brush to brush. Production rate may be varied from 10 to 30 pieces a minute according to type of turning and variety of wood, providing the best results in sanding.

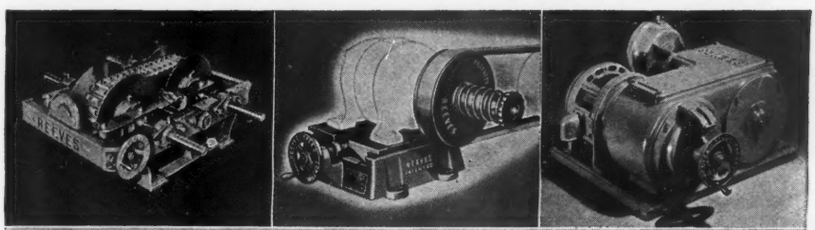
GRINDING

A vertical design REEVES Motodrive replaced rheostat control on this new grinder at a substantial saving. All vibration is eliminated through mounting the Motodrive on live rubber. This compact, self-contained variable speed power plant provides infinite speed selectivity of headstock speeds as required by differences in diameter of shafting which this grinder handles.

TAPING



This is a two-head taping machine manufactured by the New England Butt Co. It is used to apply paper or friction tape to cable. Since smaller sizes of cable can be wrapped faster than larger sizes, variable speeds are essential for greater efficiency. This is accomplished through regulation by a REEVES Variable Speed Transmission, which provides any desired operating speed and enables this machine to handle cable of different kinds and sizes up to 1½ inches in diameter. Operator selects proper speeds as needed merely by turning handwheel control.



THE 3 BASIC UNITS IN THE COMPLETE REEVES LINE

VARIABLE SPEED TRANSMISSION. Provides infinite speed adjustability over wide range. Accurate and positive at all speeds. Modern, compact open and enclosed designs, vertical and horizontal. Fifteen sizes—fractional to 100 h. p. Speed variations from 2:1 to 16:1 inclusive.

VARI-SPEED MOTOR PULLEY. Simplified development of Transmission. Mounts on standard shaft of any constant speed motor. Forms direct drive to machine. Sliding motor base is moved forward or back for speed changes. Seven sizes—fractional to 7½ h. p. 3:1 range of variation.

VARI-SPEED MOTODRIVE, Combines in one compact, self-contained enclosure, constant speed motor, REEVES speed varying mechanism and reduction gears (where required). Available in space-saving horizontal and vertical types—¼ to 10 h. p. Speed variations 2:1 to 6:1 inclusive.

REEVES ADVANTAGES

Positive transmission **of power at any speed and under varying loads; no slippage or fluctuation.**

High efficiency **. . . negligible loss of power transmitted.**

Simplicity of design **and operating principle . . . few moving and wearing parts; long life and trouble-free service.**

Wide range **of designs, sizes, speed ratios, controls . . . insuring the correct application for your individual needs.**

A nation-wide **engineering organization . . . at your service, without obligation.**

★ MODERN
★ ACCURATE
★ TIME-TESTED

REEVES SPEED CONTROL

REEVES PULLEY CO., Dept. F, Columbus, Ind.
Please send information on your complete line of speed control equipment and how it is being used to improve production processes and cut costs.

NAME.....

COMPANY.....

ADDRESS.....

like shop sanitation and convenience.

In conclusion, after more than a quarter century of experience with arbitration and the minimum wage, Australia is satisfied with her choice. The system does not work to the entire satisfaction of the public, of labor, or of the employer, but all agree that the results are better than would be possible under supervised private negotiation. All are agreed that the lower-paid groups are better off than they were prior to arbitration and than they would be again under a system of private and uncompelled negotiation. They are proud to claim that Australia can lift its head and say that it treats men as men, not as pawns in a ruthless industrial game where some fare well and others sink to wretchedness.

It Won't Be Easy

Finally, to Americans seeking light as to the possible use of arbitration and the minimum wage, they say:

"1. The methods will not work with courts composed of members of short tenure, whether elected or appointed.

"2. A smoothly working system cannot be installed overnight. It must come by evolution. Much amendment in law and procedure was needed to bring the Australian system to its present stage. Even now it is not all that could be desired.

"3. A period of stress must be expected during the early experimentation, which is sure to last for quite a few years. During it, each of the chief parties will, in turn, want to throw the system overboard.

"But the attainment of a workable system is possible and is worth while. Stick to it."

A Qualification. It is evident, then, from Australian testimony, that arbitration and the minimum wage, as mechanisms of industrial adjustment, work quite well. Viewed as integral parts of an economic system, the judgment needs qualification.

The typing of the basic wage to the cost of living is certainly desirable when living costs are rising, otherwise the standard of living would be reduced. But the effect is not without problems. Further, even we in America, with a system of free negotiation, do raise wages as living costs go up, although the wage always lags behind and the increase may not be in proportion to the rise in living costs. But under the Australian system living costs and wages step up alternately and by equal amounts. Thus there is created a spiral in production costs. In turn, this affects the position of the Australian manufacturer in competition with foreign goods. In his home market his remedy is to ask for a higher tariff; and it has been the policy of successive governments to grant it. But it puts him out of competition in overseas markets.

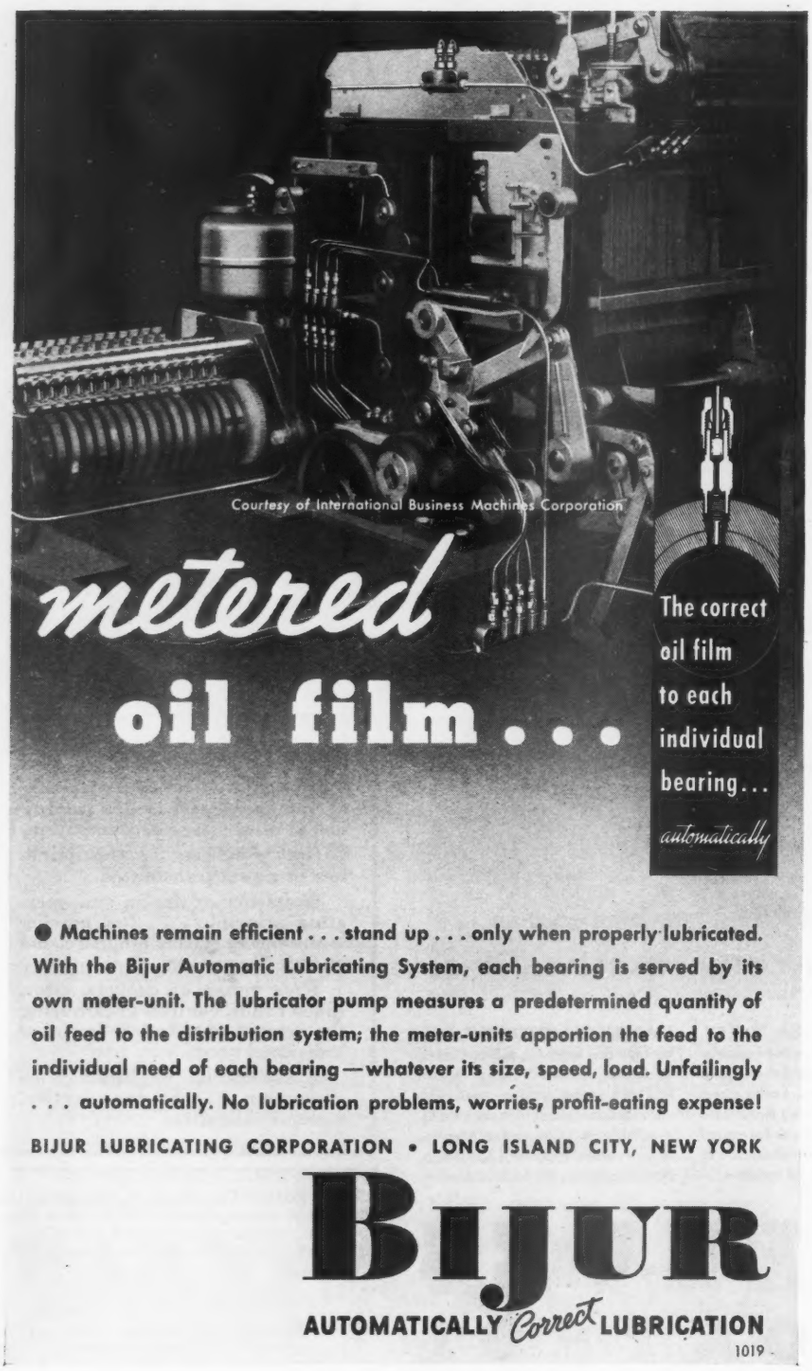
Not So Steep a Spiral

It is to be noted that this effect applies particularly to a country still young in its manufacturing experience. For the United States, where manufacturing is more mature and production per worker has gone up quite fast, such a steep spiral is not to be expected. Cost-saving machines and methods have tended to keep costs, and therefore prices, down despite rising wages. In fact, this is one of the outstanding contributions to modern economy made by the highly industrialized countries.

It is apparent, therefore, that if America tied up her wages to living costs and was unable to keep production costs down, she would be seriously affected in her export trade.

On the other hand, should costs fall on account of further mechanization, it is not to be expected that either American labor or the American public would accept a proportionate drop in wages. They might do it in an emergency, if living costs had dropped sharply and in a large percentage, as in a time of severe depression.

Therefore, if we continued to lower our production costs and did have an arbitration system, we would still have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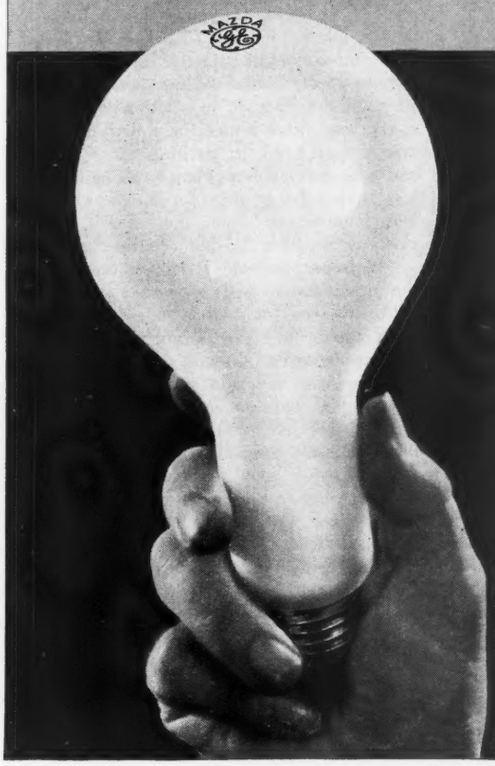
GENERAL ELECTRIC ANNOUNCES

Brighter MAZDA lamps

NEW LOW PRICES



SIGHT SAVING SIZES REDUCED AS MUCH AS 25%

The 19th Major Price Cut in 17 Years
Effective April 1st, 1938

SIZE	WAS	NOW
75 WATT	20¢	15¢
100 WATT	20¢	15¢
150 WATT	25¢	20¢
50-100-150 WATT	50¢	45¢
100-200-300 WATT	65¢	60¢
200 WATT	35¢	30¢
300 WATT*	60¢	50¢
500 WATT (Clear)	$1.40	$1.20
Clear, medium base.		
Silvered Bowl Lamps		
100 WATT	60¢	55¢
150 WATT	70¢	65¢
200 WATT	95¢	85¢
300 WATT	$1.45	$1.35
500 WATT	$2.25	$2.05
Daylight Lamps		
100 WATT*	35¢	30¢
150 WATT	50¢	45¢
200 WATT	80¢	75¢
300 WATT	$1.20	$1.15
500 WATT	$2.15	$1.95
Inside frosted.		

Space does not permit the listing of all the types and sizes of lamps made by G-E. Many other lamps are also affected by this latest price reduction, including lamps for streets, highways, trains, locomotives, and street cars.

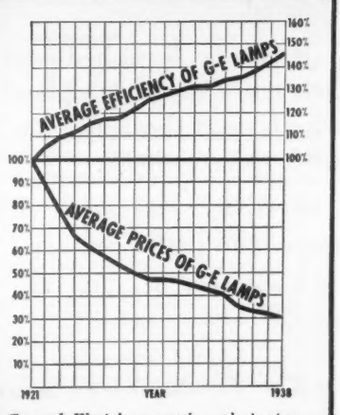
"They stay brighter longer!"

Better light for shops, offices, factories

On April 1st General Electric announces a double saving for every shop, office, or factory that wants better light for better sight: *First*, new brighter MAZDA lamps that *stay brighter longer* and give more light than ever before. *Second*, General Electric's 19th major price reduction in 17 years. New low prices on sight-saving sizes used in the home, stores, offices, factories, schools, and transportation.

These new, brighter MAZDA lamps and new low prices offer you great advantages toward bringing lighting standards up to the modern requirements for efficient, safe seeing. They make your lighting costs lower than ever.

Because of this continued policy of offering better and better MAZDA lamps at lower and lower prices, it pays to insist that the lamps you buy carry the famous G-E monogram on every bulb. General Electric Company, Nela Park, Cleveland, Ohio.



General Electric research and development are constantly at work to increase the light output of MAZDA *lamps and to reduce prices. The above chart shows graphically what has been accomplished since 1921. Average bulb prices are down 70% . . . while average efficiency has climbed 46% in the same short time.*

GENERAL ELECTRIC

A low-priced Lift Jack Truck with the advantages of high-priced types.

Simply pull down the handle and the truck lifts off the front legs and is ready to roll to destination. Lift the handle and the Jack rolls out and stands alone.

The Fairbanks Lift Jack Platform Truck lifts and rolls easily. It can be turned in a small space. Although small and light in weight, it is very powerful. Has no pins, ratchets or levers to operate.

The platform is made of well-seasoned oak. All parts are well proportioned. Wheels are broad faced. Throughout, this Lift Jack Platform Truck is ruggedly constructed.

It can be furnished with various types and sizes of semi-steel wheels and bearings, or with rubber-tired wheels.

Backed by an experience of more than half a century.

Write for Booklet J-1 and prices.

The Fairbanks Company

Hand Trucks, Wheelbarrows, Dart Unions and Valves

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to expect constant argument that labor should share in the resulting profits and prosperity.

American labor has so shared for several generations, even if not in true proportions. Obviously the demand would become more vigorous if we had arbitration. However, as a result of the depression, American employers are not averse to that argument. Even very conservative employers have come far in their thinking on wages and labor relations since 1929.

When Controls Won't Work

(Continued from page 74)

side of the circuit and many others are intentionally grounded for operating or safety reasons. One ground on a circuit is therefore no particular menace; it is the second one that makes the situation serious.

In the diagram let us assume that the circuit is permanently grounded on the negative line, as indicated, and that a second ground develops at point *A1* on the armature circuit. Upon starting current would pass through the starting resistor and then through the grounded point to the negative line. Some current might pass through the armature, depending upon the value of the grounded circuit's resistance. The increased current in the starting resistor would probably overload it. However, when it is finally short-circuited by accelerating contactors *1A* and *2A* a definite short circuit from one side of the line to the other exists.

Grounds at points *1* and *2* in the control circuit may start the motor by duplicating the start button circuit; at points *2* and *3* they might prevent stopping the motor by paralleling the stop button; at *3* and *4* grounds would parallel the overload contacts and eliminate overload protection.

It is practically impossible to mention all situations that may occur from grounded circuits. Certain it is, however, that any precautions taken during installation to prevent grounded circuits will be repaid later in uninterrupted service and elimination of the time and expense involved in locating and removing them.

Any experienced operator can recount fascinating tales of curious and mysterious conditions resulting from circumstances that were most unusual. Only those present who observed the final results could eventually find the reason and solution. Although the points enumerated above may not be the final answer to a definite problem, they may point the way to a final solution.

Sayings and Doings

•

Weed Says Industry Must Evaluate Jobs

American industry will eventually have to keep step with Europe and set up a system for evaluating men and jobs, D. W. Weed, head of the wage payment section of General Electric's Manufacturing General Department recently told the Hartford Chapter of the National Association of Cost Accountants meeting at Farmington, Conn.

"Will industry undertake this work for itself? Or will the government have to do the job for industry?" asked Mr. Weed. "The fundamental objective of job evaluation is to determine values for individual jobs and for one job in relation to another. Every man who works for a living is primarily interested in earning more money, and when a man feels that he is being paid less than another man for a job which is more important than the other's, there exists a basis for a labor relations problem.

"A proper system of job evaluation, on the other hand, will encourage people to fit themselves for better jobs by showing them where they are falling short in their present capacity. It will provide a promotion sequence and point out how and where a man will have to improve to fit himself for a better job. Familiarity with the system will show the limits of a man's present job and bring home to him the possibilities of some higher rate position."

Mr. Weed went on to describe the system used by General Electric throughout its manufacturing organization, stressing the fact that the hardest as well as the most important step in setting up a system of job evaluation is the derivation of a key list of jobs.

"This work," he said, "should be done by a committee so that all parts of the organization will be in agreement with the supervisory staff. It is essential that the fundamentals of the system hold for the entire factory force so that the possibility of discrimination will be eliminated at the start."

•

The Real Measure of Wages

Too much thought is given to what a worker may earn, either on an hourly or weekly, or even on an annual basis, in terms of money. We forget that money is purely a medium for exchanging labor in one form for labor in another form. What a worker can get for his labor depends upon the prices which he has to pay for the labor of others.

On this basis, figures indicate that the General Motors worker's ability to buy has been going up steadily for many years past. Money wages have greatly advanced, but superimposed upon this is the fact that the things he buys costs less today,

HOW TO SAVE MONEY IN YOUR PLANT with Automatic Process Control

9 Years ago in Alabama Taylor Coordinated Instrumentation was working for Industry. Today in modernized and even more efficient form it is available for your plant. Send coupon for the Taylor Consulting Service

THE TREND toward the fully automatic control of entire processes may be recent. But the means for doing it are not new.

Nine years ago Coordinated Instrumentation as developed by Taylor Engineers began to operate in process industries.

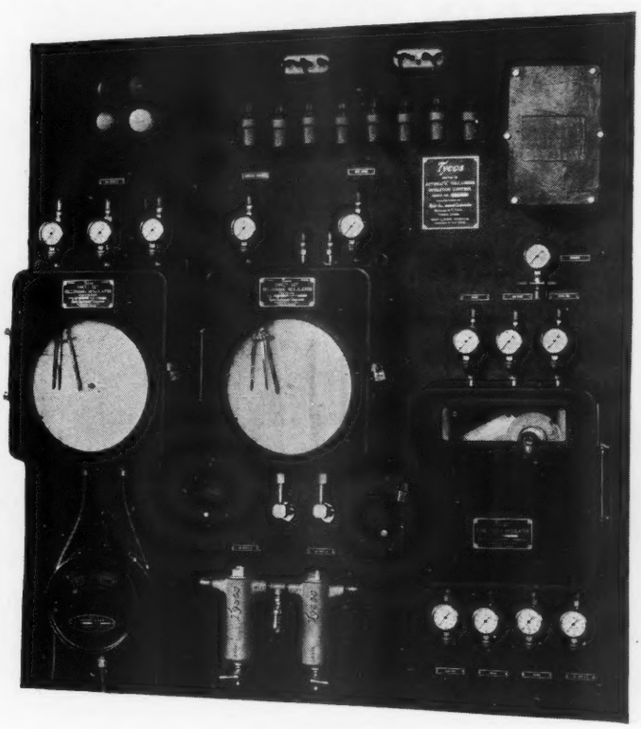
At that time twenty-six Taylor Systems of Control, illustrated by the panel board shown below, were designed and built for the Gadsden Plant of the Goodyear Tire & Rubber Company. Twelve more units were constructed for a tire and rubber plant in South America.

Ever since then, these thirty-eight systems have been automatically controlling time, temperature and pressure in curing all the tires made at these two plants. And since 1928 Taylor Systems of Coordinated Instrumentation have been helping to produce many products in rubber, brewing, textile, tobacco, food and other fields.

What is Taylor Coordinated Instrumentation? It designates process control in which two or more variables are controlled in a predetermined relation to one another. This includes installations all the way from a Single Taylor Time-Schedule Controller to a complex system in which several instruments are coordinated and interlocked to carry on completely an intricate process. The latter system is built around a Taylor Time-Cycle Controller, the complete master of a process cycle, which controls a series of operations according to a hard and fast schedule to produce a product of precise characteristics and qualities.

Taylor Coordinated Instrumentation guarantees reproduction of a processing schedule at any time—every time. It is one of the best assurances of uniform quality. It speeds the production flow. It practically eliminates waste and seconds. It saves money... cuts production costs. It increases net profits.

Taylor Coordinated Instrumentation is an investment whose returns exceed the money invested. Let us fit it to your needs in your plant. To get the services of engineers who know industry's problems and will help you apply this control to your processes, just fill out and send in the coupon. Taylor Instrument Companies, Rochester, N. Y. Plant in Toronto, Canada. Manufacturers in Great Britain—Short & Mason, Ltd., London, England.



IN 1928

Taylor began work in Coordinated Instrumentation on an extensive scale. The illustration shows panel board of system designed for the Gadsden, Alabama, plant of Goodyear Tire & Rubber Company. This Taylor System successfully controlled factors of time, temperature and pressure in curing tires made at this plant and have been in continuous use ever since.

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Indicating Recording • Controlling

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Taylor Instrument Companies
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Gentlemen: I want to know about Coordinated Instrumentation and what can be done to apply it to my plant and product. Please see that I receive full information.

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Standard Browning **DIESEL,** *Gasoline, or Electric*

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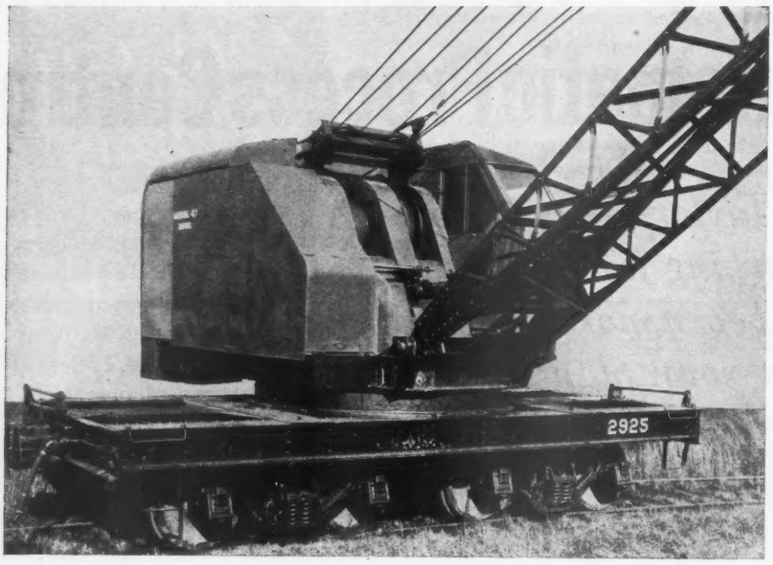

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Wire for Practically All Purposes and
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offer widest range of sizes and types for either high speed or low speed application.

Tires 8" to 24" overall diam. size. Load capacities range from 180 lbs. to 1500 lbs. 2-4 and 6-ply with separate inner tubes and heavy duty wheels. For all types of hand operated and motorized industrial equipment. List of users includes many of best known names in industry. Write for more detailed information and list of manufacturers supplying equipment on Jumbo Jrs.

PIONEER OF THE SEPARATE TIRE, TUBE AND WHEEL PRINCIPLE

THE GENERAL TIRE & RUBBER CO.
Akron, Ohio

in money, than in 1929. For example: *The weekly wages of the average General Motors employee in 1936 bought nearly one-third more of the necessities and luxuries of life than did his weekly wage in 1929.*

And these higher earnings did not result from workers being employed abnormally long hours—quite the contrary. The average in General Motors plants in 1936 was 40.5 hours per week, while in 1929 the average was 41.5 hours. In other words, in 1936 the General Motors worker was able to purchase 30 per cent more of the necessities and luxuries of life with one less hour's work per week than in 1929. Furthermore, General Motors in 1936, voluntarily established a standard 8-hour day and a 40-hour week, with time and a half for all work above these daily and weekly totals.

ALFRED P. SLOAN
Chairman, General Motors Corporation
(From "The Worker in General Motors")

•

More People at Work

Criticism of the increase in the use of automatic machinery in modern machinery, heard recently in some quarters, is without justification. Automatic machinery does not make *fewer* jobs; it makes *more* jobs. They may be different jobs, but more jobs, nevertheless.

Labor-saving devices alone have made possible most of the larger industrial operations in which great numbers of men are employed. Without such devices, the $500 automobile would never have been made possible, and automobiles would not today be within the reach of the purses of millions who are now able to afford their own cars.

Automatic machinery and labor-saving devices have put to work eight times as many persons as were originally employed in making the same articles, when they were built by the old-fashioned hand method. In the case of the automotive industry, these additional workers are engaged in selling, servicing cars and in building and equipping garages.

Throughout the entire industrial picture, more people are working today because of automatic machinery and the increased production that it makes possible.

America has more automatic machinery than all of the rest of the world put together and, because of that fact, it is able to put more of its people to work than any other country.

WILLIAM F. O'NEIL, *President*
General Tire & Rubber Co., Akron
(From an address before the Advertising Club of New York)

•

A British Viewpoint

Without comment, I pass along the following article from a recent issue of the *London Sphere*:

"The United States contains 6 per cent of the world's area and 7 per cent of its population. It normally consumes 48 per cent of the world's coffee, 53 per cent of its tin, 56 per cent of its rubber, 21 per

It May Surprise You To Learn

THERE ARE OVER 50 DIFFERENT

SCOTCH ADHESIVE TAPES

(FOR INDUSTRIAL USE)

Made to meet industrial operating problems, Scotch Adhesive Tapes help to increase production and lower manufacturing costs.

Tapes for Masking, Sealing, Protecting, Reinforcing or Electrical work, from the thinnest tissue to extra heavy thickness, are but a few of the many different types.

Scotch Adhesive Tapes seal without water—will not dry out or loosen or leave residue when removed.

One or more of these tapes may help solve a production problem for you.

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We would like to try Scotch Adhesive Tape for the following purpose:_____

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SCOTCH ADHESIVE TAPES HELP SOLVE PRODUCTION PROBLEMS

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JACKS FOR ANY LIFTING JOB
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The Duff-Norton Genuine Barrett 4-Way General Purpose Jack No. 1523.
Be prepared for any lifting emergency with genuine Duff-Norton Jacks—those faithful beasts of great burdens that are backed by an international reputation for speed, safety and dependability and fifty years of progressive specialization.
Elephantine strength is built into every lifting unit whether the job calls for one ton or 100 tons or more—the kind of jacks in which you can place the greatest confidence.
Play safe—specify Genuine Duff-Norton Jacks from your Mill or Mine Supply Dealer and get the best.
THE DUFF-NORTON MANUFACTURING COMPANY
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The House that Jacks Built

cent of its sugar, 72 per cent of its silk, 36 per cent of its coal, 42 per cent of its pig iron, 47 per cent of its copper, and 69 per cent of its crude petroleum.

"The United States operates 60 per cent of the world's telephone and telegraph facilities, owns 80 per cent of the motor cars in use, operates 33 per cent of the railroads. It produces 70 per cent of the oil, 60 per cent of the wheat and cotton, 50 per cent of the copper and pig iron, and 40 per cent of the lead and coal of the globe.

"The United States possesses almost 11 billion dollars in gold, or nearly half of the world's monetary metal. It has two-thirds of civilization's banking resources. The purchasing power of the population is greater than that of the 500 million people in Europe and much larger than that of the more than a billion Asiatics.

"Responsible leadership which cannot translate such a bulging economy into assured prosperity is destitute of capacity. But pompous statesmen, looking over the estate, solemnly declare that the methods by which it was created are all wrong—must be discarded—that the time has come to substitute political management for individual initiative and supervision."

To characterize any such proposal, I join with the *London Sphere* in labeling it "just d— foolishness!"

HOWARD C. SEAMAN
Secretary-Treasurer
Cinaudagraph Corporation
Stamford, Conn.

•

Profit Sharing for Executives

Profit-sharing plans for executives have proved more successful than similar plans covering wage earners, according to a study made by the National Industrial Conference Board.

This new study, which supplements a previous Conference Board study dealing with profit sharing for wage earners, is based on information received from 84 companies employing 539,564 persons. The following is a summary of the facts presented:

Major executives alone were eligible to participate in one-third of the plans, minor executives were eligible under two-thirds of the plans, while supervised executives, such as foremen, participated under 15 per cent of the plans.

Management's share was taken directly from net profits in 32.1 per cent of the plans, the percentage allotted to the profit-sharing fund ranging from 3 per cent to 20 per cent of net profits.

Management shared in the profits after deduction of earnings for capital in 51.2 per cent of the plans. The dividends deducted varied from 5 per cent to 12 per cent. Management's share of the balance varied from 5 per cent to 50 per cent.

In slightly less than half of the companies, salaries were stated to be lower than they would otherwise have been because of the profit-sharing plan.

In 37 companies employing 331,914 persons, only 3,169 executives, or 0.95 per cent of the total number employed, participated in the profit-sharing plan. The percentage of participation in the individual

PROFITS FROM INSTRUMENT CONTROL

Another costly "Guessing Game" eliminated

Moisture content has been an age-old guessing game in the paper-making field. "Too wet" or "too dry" spells w-a-s-t-e in time, product and power. Foxboro Control automatically provides the exact degree of moisture proper for every sheet of paper.

Eliminating costly guessing from manufacture, through the control of temperature, flow, pressure, liquid level or humidity, is Foxboro's service to industry. From the simplest to the most complex control problem, Foxboro has the solution. It is this combination of unequalled application experience which assures you results.

Consult a Foxboro engineer. His knowledge is at your service. Let him help you make better, more uniform products for less money with modern control. The Foxboro Company, 24 Neponset Avenue, Foxboro, Mass., U.S.A. Branch Offices in 25 Principal Cities.

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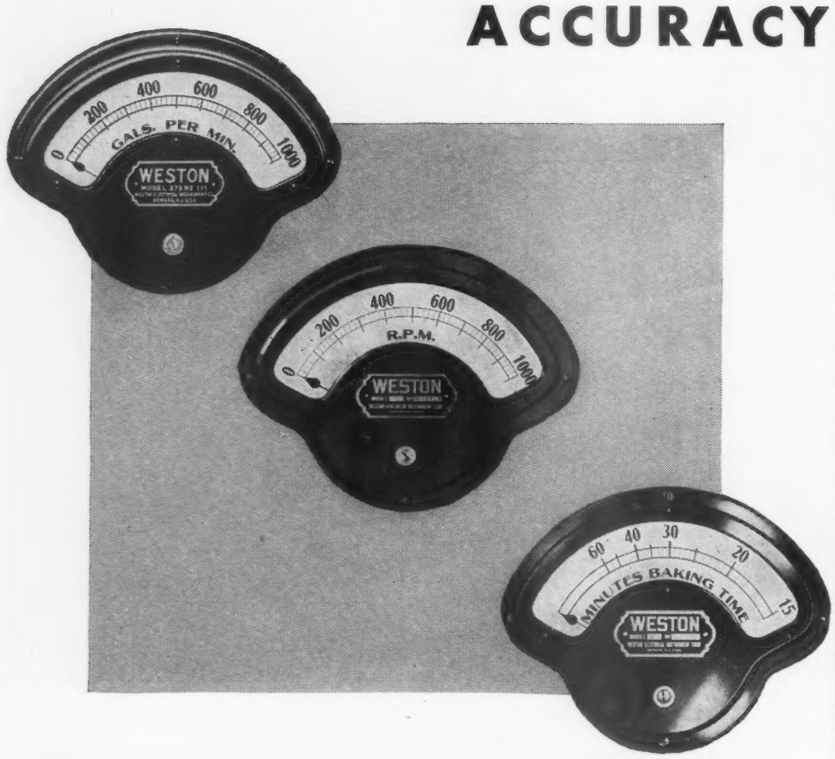

WESTON *Electrical* TACHOMETERS

SIMPLE . . . electrical indication of R.P.M. or any of its functions, requires only mounting the sturdy magneto at the rotating part, and quickly wiring it to the electrical indicator.

FLEXIBLE . . . one or more indicators can be used, calibrated as desired, and mounted any distance remote from the drive.

ACCURATE . . . magneto-indicator relation is unvaryingly proportional; and the indicator follows all speed changes smoothly and instantly.

Complete information on WESTON Electrical Tachometers will gladly be sent on request. Weston Electrical Instrument Corporation, 628 Frelinghuysen Avenue, Newark, New Jersey.

WESTON *Instruments*

companies ranged from 0.01 per cent to 9 per cent.

Only 8 plans were reported to have been discontinued. The depression and retarded recovery were given as the chief reason for such discontinuance in a majority of cases.

•

19 States Pay First Unemployment Benefits

More than $1,500,000 in unemployment benefit checks were paid to eligible unemployed workers in 19 states during the first week and a half of benefit payments, according to an announcement of the Social Security Board.

Reports based on figures compiled by state unemployment compensation administrators covering operations from January 24, the first day on which benefits were payable in any state, through February 3, show that 160,747 checks totaling $1,581,-218.52 were issued during these 11 days as compared with 14,908 checks totaling $150.387.48 issued by 10 states during the first 5 days of this period.

Duplication Possible

While the total number of checks thus far issued in all 19 states reporting probably represents benefits paid to an equal number of different persons, exact information is not yet available on this point, and it is possible that a certain number of the checks included in this total are second checks made out to the same individual and covering his second compensable week of unemployment.

Also, in order to catch up with the large initial volume of benefit claims, a state agency, during the first few weeks of its benefit payment program, may within the same week issue more than one check to a person covering two or more previous compensable weeks. It is expected that later reports from the state unemployment compensation agencies will indicate not only the total number of benefit checks issued and the total amount of such checks, but the number of individuals receiving payments as well.

•

Multiple-Section Housings Are Newest in Plastics

It is no longer necessary to think of plastic molding as essentially a one-piece operation. A new method, by which housings are molded in sections and assembled, makes plastics available for many large industrial jobs hitherto deemed impossible.

Pioneer job of this type is the new scale housing molded by Reynolds Spring Company of Jackson, Mich., for the Toledo Scale Company. It reduces the weight of the whole scale by 64 per cent—from 160 lb. to 58. Its 10 lb., 2 oz. of plastic is said to be the largest amount ever used in a single job. The housing of one model is assembled from seven plastic moldings, the other from eight pieces.

To say that a large number of mechanisms "lend themselves" to an assembled plastic housing, seems not to be overstatement.